1 Introduction

1.1 It is a well worn truism that construction used to be a much simpler affair than it is now. The flow of information between people designing and constructing a building formed an autonomous system; the items of information themselves were simple and rooted in relatively unchanging conventions. Many of them—size of door, quality of finish, terms of contract—were generated specifically for the project, independently of the 'outside' world. Ways of conveying information—drawing, specification, word of mouth or even the informal understandings between people taken for granted in a society more stable than our own—could be unelaborate, direct and individual.

1.2 We now need to improve the information system which has evolved, based as it is on intuitive understanding of needs, and to develop it into a rational co-ordinated system, building on and enhancing its best features. We need, in a sense, to recreate the simplicities of the past to enable us to deal with the increasing complexity of construction and the proliferation of data. We must find a way of restoring direct, economical and unambiguous communication between client, designer, constructor, materials supplier and national bodies. Our report recommends a method and outlines the work necessary to bring such an information exchange into being. It summarises the findings of a number of study teams and consultants and proposes a programme of implementation.

1.3 The need for improvement of communications began to be apparent in the late 1950's, and in 1961 the RIBA introduced the SfB system of classification, first developed in Sweden, as a common language for the building industry. In 1963 the Joint Consultative Committee of Architects, Quantity Surveyors and Builders launched the Building Industry Communications Project. Since then many local authorities and large firms of consultants and contractors have developed information systems of their own; institutions and commercial organisations have widened the scope of the information services they offer.

1.4 In May 1966 the Minister of Public Building and Works established a Committee on the Application of Computers in the Construction Industry (CACCI) which in turn commissioned a study of Coding and Data Co-ordination from the Building Research Station. BRS completed the study in 1968[1] and the CACCI proposed that the National Consultative Council should start implementation of its recommendations by means of this Working Party. We first met in March 1969 and were supported by a full-time group of Ministry staff which could form the nucleus of a data co-ordination advisory service to the industry.

1.5 Our terms of reference were:

> "To consider proposals for the improvement of information flow in the construction industry; to advise on all measures necessary to implement the proposals taking into account the need to secure widespread industrial co-operation in the adoption of any uniform system and the need for compatibility as far as possible with existing and future developments in or affecting the industry; and to report to the National Consultative Council".

1.6 To fulfil our terms of reference we in turn appointed study teams, each led by a working party member; and each, with assistance from academic or research organisations, concerned itself with a particular aspect of the field. In any area where the volume of detailed work necessary was too great consultants were commissioned to carry out studies for us. Appendix 1 shows the membership and terms of reference of the study teams, together with the terms of reference and names of consultants who carried out other studies.

1.7 For lack of time and resources the BRS report did not cover civil engineering, so we also commissioned Freeman Fox and Partners to prepare a study to fill the gap[2].

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(1) Details of this and all other references will be found in the Table of References on page 34.

1.8 We were reluctant to inflict yet another enquiry on an industry already saturated with questionnaires and interviewers, but the response was gratifyingly good. We are confident that the principles identified in our consultants' reports interpret the opinion of the industry within the scope of their studies but the limited statistical basis of the surveys implies need for further detailed discussion on the principles of practical application of our recommendations.

1.9 We would like to thank all those who by serving on our Study Teams, giving their time freely to the consultants employed on our behalf, or making available the results of their own work, have contributed directly or indirectly to this Report. Our particular thanks are due to Mr R Geary of the National Federation of Building Trades Employers for leading the Study Team on Commodity Identification, and to Professor L Fletcher, of the Royal Institution of Chartered Surveyors, for leading the Study Team on Classification Categories. In addition we would like to thank the group of services engineers led by Mr A Foster of the Heating and Ventilating Research Association who voluntarily formed a Mechanical and Electrical Services Working Group on Data Co-ordination to assist us in our deliberations where these matters were concerned.

2 Data Co-ordination and information flow in the construction industry

The problem

2.1 What exactly is the 'information problem'? It has been referred to so often in discussion, lectures and papers that its meaning has widened and blurred. Where a group of people working together on an enterprise speak the same language, use the same terms in the same senses and order communication between themselves or between their group and other groups in common units, there is no 'information problem'. In the construction world we have lost this unity.

2.2 Each project brings together client, designers, contractors, suppliers, public authorities and institutions in an association solely for that project. Each member of the association has his own internal information system which must, in part, mesh with those of other members. At the same time, each member will be engaging in other associations for other projects, each with a unique information system in whole or in part. If now we add the dimension of time, a relationship between present, past and future information becomes evident. The need, then, is for information transmitted and received to be in a common currency, to be in terms that require no translation.

2.3 In essence the 'information problem' in the construction industry is a partial failure of communication. No contractor on first encounter with a set of project drawings can be sure where to find a particular piece of information—or indeed that it will be shown at all. No designer searching for data about a product to meet his design needs or a research report relevant to the particular situation can be sure that he will be able to find what he needs quickly or whether it exists at all. Decisions are delayed or taken on hunch simply because of the effort required to collect the relevant data. Throughout the system there is duplication of effort, and translation and regeneration of information. Time is spent in recriminations as to *who* is to blame for the failure of communication when really it is the *system* which is at fault.

2.4 In our deliberations to try to find a remedy for the situation we have found it necessary to analyse the problem into:

(a) the *procedures* by which operations are performed on data so that information about a project can be generated—eg procedures for preparing plans from the client's brief, for designing the frame for a building, for preparing a bill of quantities, for management of design and construction etc;

(b) the *stores* of data or information used in the process, such as text books, codes of practice, manufacturers' catalogues, and the generated information embodied in the set of drawings, specification and quantities for a construction project;

(c) the *flow* of information between those engaged in the process.

We have not concerned ourselves to any great extent with the first of these—the procedures for generating project information. Computers must play a large part in the unification of procedures and in storage and co-ordination because of their data handling facilities, but this is a vast problem area which we consider to be largely the province of the Committee on the Application of Computers in the Construction Industry. We have therefore dealt with the way in which the resulting information should be arranged, cross referenced, and presented so that it can be used more effectively and made to flow more readily.

2.5 We have also found it necessary to think of different kinds of information, depending upon who has access to it. Each member engaged in helping to design and build a particular project formulates or draws upon three kinds of information:

Specific to a project

client's brief; production drawings; conditions of contract; heating calculations, correspondence and so on: all particular to that project, and available only to those engaged on it.

General

codes of practice; manufacturers' catalogues; building regulations; research reports; standard methods of measurement and so on: all of them not particular to the project but applicable to any project, and available to everybody.

Specific to an organisation or firm

office standard details; cost and output records; manufacturing techniques and so on: available only to members of particular firms engaged on the project, but some of it relevant to other projects.

2.6 Clearly there is a flow between these three categories. Experience of a particular project contributes to office standard details; research reports to project drawings; etc. Project information may become general information on completion of the project and be fed back to data stores. There is also interchange *within* a particular data store: between client's brief and production drawings; between manufacturers' catalogues and building regulations and so on. We illustrate this in simple diagrammatic terms in Figure 1.

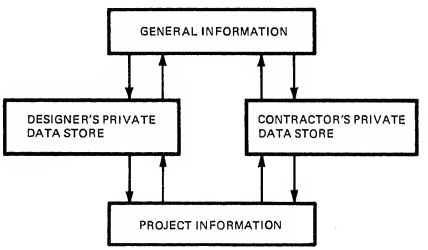

Figure 1

2.7 The flow of information is illustrated in greater detail in figure 2 below*. The heavy black boxes in the second column show the procedures by which the industry performs its tasks. In doing so it draws upon the stores of general information shown in the three right hand columns and generates information specific to the project—the project information. Firms and organisations engaged in the process also draw upon their own private data stores for information specific to their own organisations to serve the management information systems indicated in the left hand column.

*Adapted from a paper presented to the Economic Commission for Europe by W J Reiners of the Department of the Environment at a seminar in Moscow.

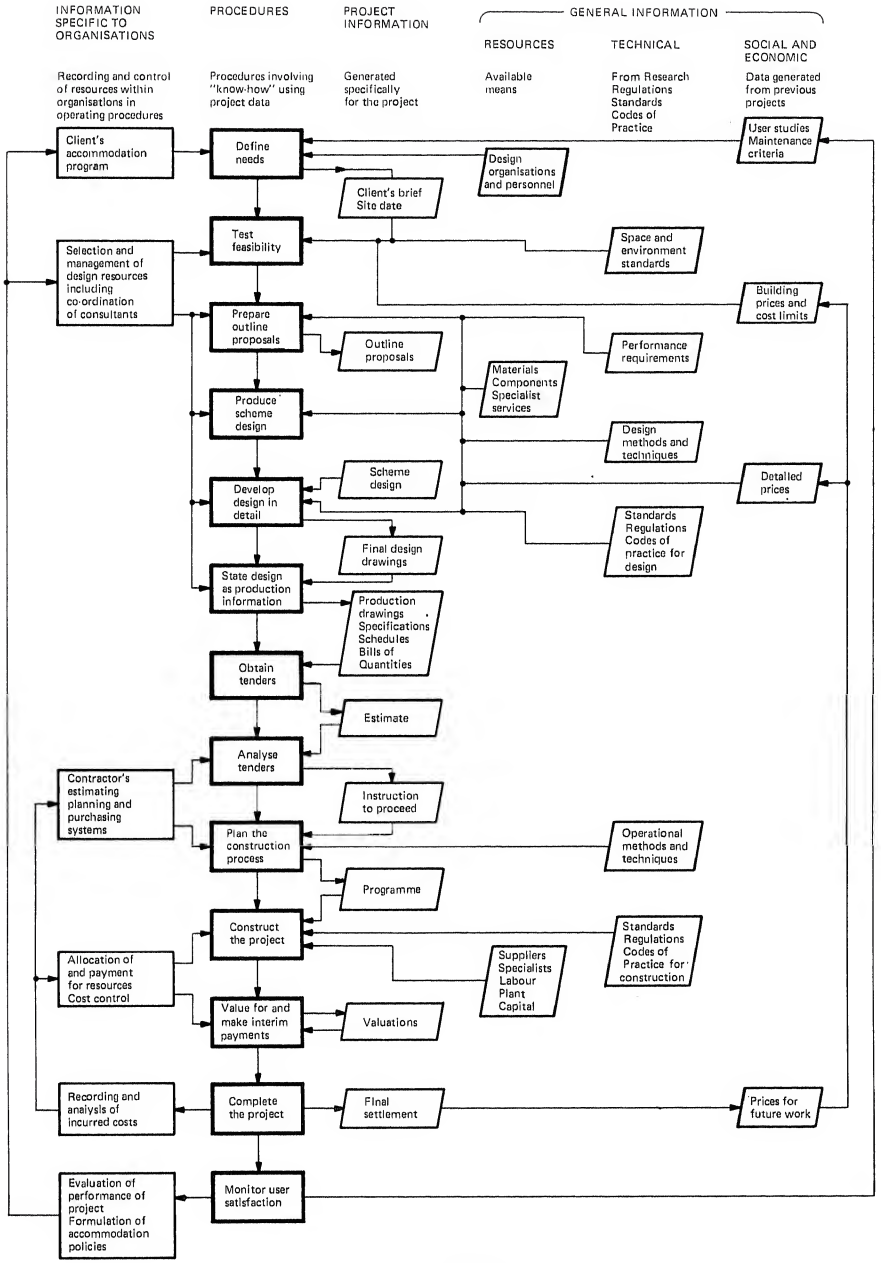

Figure 2

2.8 These exchanges are obstructed by incompatibility of information structure; that is, the way in which information is divided, grouped and presented. Two examples will illustrate this: information in a bill of quantities is rarely organised on the same basis as information in the production drawings and neither of these corresponds to the structuring of manufacturers' catalogues or of building regulations. The BRS study estimated that as a result designers spend from 10 to 20 per cent of their time searching for information. A great deal of time goes in 'translating' information from one structure into another. Useful experience gained on projects is often overlooked, so that the same mistakes tend to be repeated and good solutions or details are not re-used. Project information is generated afresh because this is easier than retrieving it from the results of previous work.

2.9 Why does information appear now as so difficult a problem? First because there is a great deal more, and more complex, information in use than formerly. Secondly information becomes obsolete and changes more rapidly. And not least, any one project is far more dependent on a wider network of standards and controls on a national scale than ever before. At the time when this rising tide appeared to overwhelm 'hand' methods of storing and processing information the digital computer came into commercial application offering storage, sorting and retrieval capabilities of astonishing scope and speed. To exploit these facilities to the full the industry must have a logical and consistent information system. Such a system will dramatically improve manual communication methods.

Costs and Benefits of Data Co-ordination

2.10 Apart from the benefit which will accrue we had uppermost in our minds the likely cost of developing a co-ordinated information system and the time it would take to implement. The BRS report estimated in very broad terms that savings to the industry on new works only could not be less than £30 million a year and would be 30 times greater than the invested cost. A more detailed study carried out by consultants put the measurable potential annual benefits to the industry in the range of £150 million and the annual indirect benefit to the community at large at some £20 million. Against this, costs would be at about £12 million in the first year falling to £5 million a year after fifteen years. Full benefit would be unlikely to come in less than 10 to 15 years. A short résumé of the report of the consultants is attached as Appendix 2.

2.11 The consultants stress in their report that benefits will not accrue proportionately among different sectors of the industry and that many of the savings would be passed on to building clients in the form of better value for money. They advise that co-ordination be introduced at a pace slow enough for the industry to absorb at minimum cost and by a down-to-earth approach that will commend the system's benefits in an obvious way to those who will use it.

2.12 Whilst not accepting the calculations behind the consultants' figures in their entirety, we consider the report as a worthwhile attempt to quantify in a difficult and uncertain field. We accept the generality of their conclusions but recommend that each major project should be subjected to a more detailed cost benefit analysis before implementation.

3 What is needed

3.1 The construction industry has an information system now. It has conventions for classifying, arranging and transmitting information, it has its information stores, and information flows between the participants in the process. The system is uncertain in its quality and inefficient in the use it makes of resources. We consider that it can be improved by a process of guided evolution over a period of years to form an effective and co-ordinated system.

Components of the system

3.2 The total system we propose has four components. They are—project information, general information, information specific to organisations, and a syntax or set of rules which serve to co-ordinate and integrate the other three components. The syntax is the thread which runs through and binds together the project, general, and specific information throughout the construction process. We discuss each of these components briefly here, showing how they fit together to form a total system and the work necessary for the purpose. In Section 4 we discuss the related studies in more detail.

3.3 **The syntax of information systems.** This consists of the rules of language, terminology and classification regulating the form, flow and storage of information, including quantitative information, which will be applicable to the information systems used by the industry. If information is to flow more freely it is important to develop rules which will link the structure of all information stores and make them mutually compatible. While the rules should be relatively stable to avoid the expense of frequent re-arrangement of libraries etc. provision should be made for their revision from time to time to meet changing needs. The difficulties of securing wide agreement to such rules cannot be underestimated, but the example of the Standard Method of Measurement for Building Work indicates that agreement can be reached between two organisations in a particular field. We consider that it will be possible to secure wide agreement on more general subjects as the benefits of doing so become clear.

3.4 Different rules or conventions are required for different purposes; whilst the basic syntax will apply to all information, special rules are needed for the individual components of the total system. We have investigated the following:

- Preferred vocabularies
- The classification of information
- Graphic symbols
- The structure of project information
- Standard libraries of BQ descriptions
- Standard method of measurement
- The presentation of technical information in trade literature
- Site investigation documentation
- Codes
- Data structures
- Description of building geometry
- (and others to be developed).

3.5 In addition to these rules, others are required to formalise the procedures which generate information. As we have indicated previously, we think that these are best developed by the Committee on the Application of Computers in the Construction Industry, but we have studied such procedures as the Guide to Estimating and the Plan of Work prepared by the Institute of Building and by the Royal Institute of British Architects respectively. An example of the development of a related suite of procedures of the kind we have in mind is the development of GENESYS, a general system for engineering design, which we describe in Section 4.

3.6 **Information specific to projects (project information).** The drawings, specification, quantities and other information which comprises the project information is created

afresh by the participants in each project. Hence a set of rules or syntax is needed to define a structure, that is a standardised arrangement or presentation of project information. During the course of a project, general information is drawn into project information and use of the same syntax for both will facilitate the transfer of information between them. We consider it important where practicable that the rules or syntax should be so framed that the general information stores are arranged to meet the needs of the users of information. This means that the requirements of the project information system should take precedence over those of the general information system wherever possible in cases of conflict between them.

3.7 **General Information.** We envisage the development of libraries or stores of general information governed by the rules listed above, containing information which is in general demand throughout the industry. We have investigated the feasibility of a comprehensive file of information about commodities—the materials and components the industry uses. Other possibilities which might be investigated later are the establishment of stores of information on the availability of sub-contractors or of labour, on the performance and availability of contractors' equipment, on construction costs and costs-in use, on building and town and country planning regulations, and on standard working details.

3.8 Much of this information currently exists but is scattered and difficult to locate or assemble. Thus some of the information for a commodity file exists in manufacturers' trade literature, as does the information for a file of contractors' equipment. The Building Cost Information Service holds data on building costs. Employment Exchanges have labour records which could be held centrally to tell contractors the availability of particular categories of labour in particular areas. It is not necessary for all the data to be held in one centre, and we refer to this subject later.

3.9 **Information Specific to Organisations.** In this context we consider only that information used in the management and control of projects, such as records of costs and outputs, which may be confidential to the firms involved. We are not concerned for example with information relating to the financial standing or stability of firms, which is properly the concern of top management only.

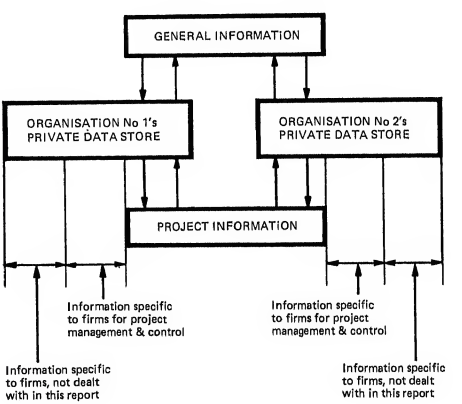

Figure 3

3.10 A typical situation can be illustrated by a simple adaptation of Figure 1 and this is made in Figure 3. Clients, designers and contractors each have a quantity of private data. Some of this, such as the project brief, design solutions and specific rates for measured work, finds its way into the project information. Other information, such as plans for future expansion, is not related to projects and is not touched upon in this report. In between is an area of data used in the control and management of a project, such as the actual output of workmen employed on a particular site, and this we are concerned with only to the extent that our object is to ensure that information shall flow to the contractor in a form appropriate to effective project management.

3.11 Information systems for project management draw upon general information (eg for materials prices) and on project information (eg for the quantity of work in a project). Project information thus becomes part of management information specific to a firm. It follows that project information must be capable of contributing to a number of differently organised management information stores. If the arrangement and organisation of information is the same for both project and private information then information can be transferred more readily between them.

The total system

3.12 Figure 4 shows what we foresee as the general sequence of work necessary to form a co-ordinated information system. Ignoring temporarily the activities shown at the top and bottom of the diagram and commencing at the left hand edge, we propose first the development of the syntax consisting of a preferred vocabulary, classification categories and codes to co-ordinate the project and general information systems. This syntax needs to be relatively stable and unchanging to act as a foundation on which to build flexible systems applicable to different situations.

3.13 The diagram then distinguishes two lines of development, the project information system at the top and the general information system comprising commodity information and other general information at the bottom. Each of these two main lines of development can proceed at a pace largely independent of the other.

3.14 The first activities to develop the project information system form a simple rationalization of the existing system. They comprise the improvement of the methods of arranging, presenting and structuring project information within the constraints of existing procedures and rules such as the standard methods of measurement, and the standardisation of graphic symbols. Next we propose a study of the needs of contractors' project management in greater depth and development of operational classification categories for project information, following which the framework of rules can be revised and a co-ordinated system for arranging project information can be developed to meet the needs of both users and producers of project information. This system should accommodate improvements in procedures for briefing and for obtaining local and statutory approvals. Finally the detailed output can be standardised to some extent by the preparation of libraries of bill of quantities descriptions and of standard working details.

3.15 For the general information system (shown beneath the project information system), we propose first the rationalisation of the presentation of technical data in trade literature, and the development of a commodity file in stages of increasing sophistication. Whilst this work is going on, other data stores to improve the general information system can be investigated and efficient procedures for feedback on the performance of materials and buildings can be introduced.

3.16 When work has been completed on data structures, methods of describing building geometry and the project file it will be possible for the total system to be operated by computer as well as manually.

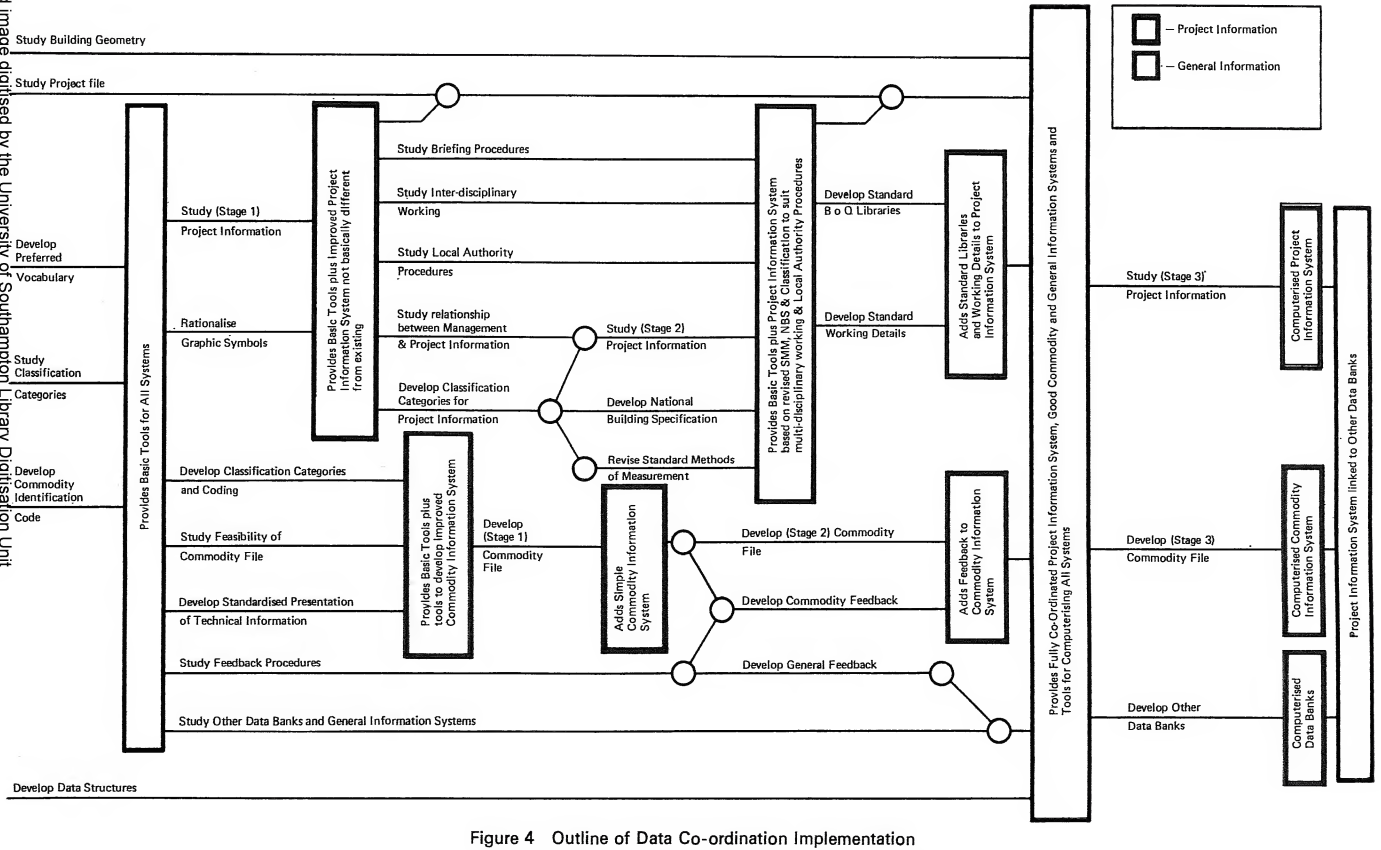

Figure 4 Outline of Data Co-ordination Implementation

Other work

3.17 There are two information dissemination and retrieval problems in the construction industry. First, the problem of information which people know they want but cannot find readily. Second, the problem of information which people need but may not know they want. In the long run a solution to this latter problem may well bring the greater benefits, because a considerable amount of research is ineffective when people do not know it exists. Improvements in information flow and effective feedback procedures would undoubtedly help to solve this aspect of the information problem but, given the present rate of technological innovation, mid-career training is likely to be more fruitful than data co-ordination and is beyond our terms of reference.

4 Progress and future work

4.1 In this Section we describe briefly the results of our work to date and outline work required in the future to develop a co-ordinated information system for the construction industry.

The Basic Syntax for Information Systems

4.2 Preferred vocabulary

4.2.1 We consider a preferred vocabulary to be an essential part of the basic syntax for project and for general information (including commodity information). A major component would be a thesaurus consisting of schedules of words used in the industry, showing in the case of synonyms which word is recommended for standard use, and showing the relationships between words.

4.2.2 A thesaurus would help information flow in several ways. Lists of up to about 20 key words selected from it could be used to describe the contents of any pamphlet, book, journal article, etc. Searching for information would be simplified because the searcher would be able to select exactly the same words from the thesaurus to describe the information he was seeking. Post co-ordinate retrieval methods by computer or optical coincidence cards would be encouraged, and the searcher could control his search by proceeding in a disciplined manner from broad and wide terms to successively narrower or related terms. False trails caused by synonymous or ambiguous terms would be avoided, and information stores would be searched for information in a systematic way. The thesaurus would have an increasingly important role to play as the use of computers increases, and it could aid the development of an unambiguous means of communication throughout the construction industry.

4.2.3 In January 1969 the Construction Industry Research and Information Association sponsored a study by the North Western Polytechnic School of Librarianship and the Brixton School of Building* to produce by December 1970 a framework of a thesaurus. It was to show the relationship between different word structures and in some cases to develop specific word lists. The extent to which the word lists would be developed to be of use to the industry would depend on progress and resources available.

4.2.4 By agreement with the Construction Industry Research and Information Association the Department of the Environment provided additional finance to increase the level of staff so as to produce by December 1970 a complete structured vocabulary of the terms used in the industry, thus providing a basic "retrieval language" whereby documentary information could be indexed and retrieved in a number of different ways and offering the industry a precise and unambiguous terminology throughout its documentation.

4.2.5 The first edition of the Thesaurus for the Contruction Industry[3] will be published shortly. It contains some 8,000 to 9,000 terms displayed in two parts. The first part displays the terms in alphabetical order. The second part displays the terms in a classified sequence which can be used as the basis of a system for the arrangement of documents in filing cabinets or on shelves, for conventional indexes and catalogues, or for post co-ordinate indexes. The schedules of terms were derived from extensive searches of current literature and have been commented upon by, and discussed with, experts on the subjects covered in each schedule.

4.2.6 We have examined the draft Thesaurus from two points of view:

(a) the storage and retrieval of information; and

(b) the provision of an unambiguous means of communication in documentation used throughout the industry.

On the first our view is that the Thesaurus requires improvement before being brought into general use throughout the industry, but that its promise is such as to be worth the

*Now the Polytechnic of the South Bank.

effort. There is an imbalance between different sections; some are treated in great depth, others require expansion; the alphabetical list needs expanding to include common but not necessarily preferred terms; and the introduction should be modified to suit the needs of those who are not librarians or other professional information workers.

4.2.7 We recommend therefore that the Thesaurus be tested in libraries in the industry both to compare its performance as an indexing language against other thesauri prepared on different bases for particular purposes in the industry and to expand the coverage of terms included, so correcting the present imbalances. Consequent upon the results of the tests a revised edition should be prepared and published for general use throughout the industry. We understand that one such test is already being undertaken in a branch of the library of the Department of the Environment, and we welcome this initiative.

4.2.8 We consider that in its present form the Thesaurus would not provide an adequate means of communication for documentation or for computer applications; indeed we think it unlikely that any one document can serve both purposes. For use in communication the schedules of words need to be accompanied by definitions to assign a precise and unique meaning to each word. We recommend therefore that a glossary of terms be prepared for use in communication, based partly upon the Thesaurus and partly on the existing glossaries published by the British Standards Institution and other organisations.

4.3 Classification of Information

4.3.1 A second major element of basic syntax needed to unify information systems is the development of a classification scheme consisting of sets of related classification categories. Classification categories are the groupings of information in libraries, information stores and documents generally so that like ideas and concepts come or can be brought together in the same groups. The industry requires, and uses now, many different classification categories for purposes ranging from filing systems to the arrangement of bills of quantities. Many of these categories are however unrelated to each other in their definitions, or in their arrangement. Thus individual concepts which occur in two or more categories intended to serve the same purpose are often differently defined and grouped with different concepts in different ways. The transfer of information between information systems is thereby impeded, and comparison of information retrieved from two different stores of information is often impossible. One example is the elemental cost analysis of buildings, where different schemes analyse the total building into different elements and comparison of cost analyses prepared under different schemes is difficult.

4.3.2 There is no complete classification scheme for the construction industry, ie a set of related classification categories, fully developed and with operational rules, which would cover every requirement of the industry. There are, however, a few schemes of long standing, mainly in the building field, which relate together a number of categories satisfactorily. Many of these use some or all of the international SfB system for which the RIBA is the UK Licensee from the International Council for Building Research, Studies and Documentation (CIB). The British version of SfB, known as CI/SfB, is not a comprehensive scheme, though the RIBA believes it has potential for much greater development. Revision of the scheme now in hand will be capable of incorporating all the terms in the Thesaurus. It has a fair range of use in the design and manufacturing sectors of the industry. Most of the trade literature in the industry is classified by CI/SfB and is arranged accordingly on shelves in many office libraries. It has been recommended by the RIBA for use as a means of arranging project information. A manual on its use for this purpose has been published[4] and private architects are beginning to use it. All or part of the CI/SfB system is made use of in the major local authority schemes for project information. It is also to be used for structuring and coding the National Building Specification. It is practicable to use CI/SfB or UDC for shelf order and to use keywords from the Thesaurus for the Construction Industry to retrieve details from the documents.

4.3.3 The partial schemes which make no use of CI/SfB include the classification contained in the Standard Method of Measurement, which has been used by agreement between contractors and quantity surveyors to arrange the information in bills of quantities for more than 40 years. The Standard Form of Cost Analysis agreed between Government Departments and the Building Cost Information Service of the RICS does not use CI/SfB coding, although many building elements are defined identically in CI/SfB and the Standard Form. The West Sussex County Council scheme adopts a more fundamental approach than others and is based on a belief in the value of the increasing use of computers and in new developments at the interface between men and machines.

4.3.4 The BRS report proposed 11 main categories needed as part of a data co-ordination framework. Some of these were already in use, while others were either absent from any existing scheme or not developed in adequate detail. The Study Team led by Professor L Fletcher was asked to consider the BRS proposals, to identify any further categories which may be needed, and to advise as to the measures necessary to implement the proposals; taking into account the Working Party's own terms of reference regarding industrial co-operation and compatibility.

4.3.5 The Study Team reported[5] to us in July 1970. It stated that there is no one set of classification categories which would be suitable for all purposes and proposed a framework of fundamental and operational classification categories which when fully developed would be capable of meeting the needs of all sectors of the construction industry. The fundamental categories would be used mainly for general information and would represent the lowest common elements of information required in the industry. The operational categories would be drawn from the fundamental categories to serve purposes or points of view which they do not cover, and used for project information systems and for information systems specific to organisations. Individual organisations could thus develop classification schemes appropriate to their own needs within the overall framework in the knowledge that there would be reasonable compatibility between them.

4.3.6 The Report recommended that the classification framework developed by the Brixton School of Building as the basis of the Thesaurus for the Construction Industry be used to demonstrate the validity of the proposals since this had almost total coincidence with the proposed system; that the proposed framework be referred to the industry for examination and testing; and that the collaboration of authors of existing classification schemes should be sought and encouraged in order to secure convergence and compatibility through the framework proposed. In view of the detailed study made of existing schemes by the Association of Special Librarians[6] as part of the work contributing to the BRS Report, the Study Team did not consider it necessary to evaluate the popularity or range of use of existing classification schemes.

4.3.7 We agreed that the Report should be sent to selected expert organisations in the industry who were developing classifications for their own purposes, asking them the extent to which their systems or activities would be compatible with the proposals and offering them the opportunity to discuss the subject with members of the Study Team; this has been done. Agreement was reached on the need for a master system for classification development. In the absence of proof, which will only be available as the result of development and testing, it is open to question whether a number of specific classification categories derived from the master system are necessary to meet the needs of different sectors of the industry, or whether a single system, which might be the master system itself, can meet these needs. It was agreed that in the first case the specific classification categories must not change too frequently as the industry needed such conventions as its working tools. Continuous rethinking of the master system would however be necessary to support new techniques and innovation in the industry.

4.3.8 We consider that the proposal of the Study Team on Classification Categories represents

a way forward to the development of a classification system which will meet the needs of the industry. We recommend that operational categories or sets drawn from the fundamental categories be developed by agreement between individual organisations, and that the fundamental categories be based on the classification developed in the Thesaurus for the Construction Industry. It will be necessary to study the extent to which CI/SfB can be adapted to converge with the Study Team's recommendations on classification categories; this work has been put in hand by the RIBA who report encouraging progress. We understand that the RIBA would be prepared, subject to satisfactory arrangements to ensure the interests of present users of CI/SfB, to suggest to the CIB that its license to 'develop, promote and administer' SfB be shared with a broader group of industry interests or even transferred to a suitable central organisation. We recommend that this possibility be further explored.

4.4 Codes

4.4.1 The third element in the basic syntax we propose consists of codes, which are needed so that information to be exchanged can be concisely and precisely identified. Codes become increasingly necessary with the growing use of computers.

4.4.2 The BRS Report considered that because the greatest saving would appear to accrue to manufacturers and suppliers through the streamlining of their procedures, the highest priority should be given to establishing a system for identifying commodities. We therefore set up a Study Team led by Mr R Geary, AIOB, to consider proposals for commodity coding for identification purposes, and to advise on measures to implement them. The Team was concerned only with the use of codes in purchasing commodities, stock control and similar applications including those for which computerised management systems were being developed by merchants and manufacturers.

4.4.3 The Study Team reported to us in December 1969[7] recommending the adoption of a commodity identification code for transaction purposes comprising three fields; sector coding authority, manufacturer or supplier, and commodity number. The optimum length of the code would be 11 characters, including a check digit, and it would employ the "stagger" technique used in the Standard Book Numbering System; sector coding authorities should be appointed to allocate codes to firms and advise on their use; and the system should encompass timber and imported items and should form a part of a national coding system being developed by the National Computing Centre Ltd. The code proposed was coincident with that proposed by the British Standards Institution in a Draft British Standard,[8] and both were based on work done by the National Computing Centre Ltd. Recommendations for implementation were also made, and were studied and accepted by a small study group of technical experts set up by the National Council of Building Material Producers.

4.4.4 After the Study Team reported, the Department of Trade and Industry was given the responsibility for co-ordinating Government policy on commodity coding having regard to the possibility of developing a national system for all industries. It is also concerned with the compatibility of international systems. We consider that implementation of commodity identification coding in the construction industry should be pursued, although we accept the reservation of the mechanical and some of the electrical sectors of the industry where 'one-off' production represents a large proportion of the commodity output or where there is a substantial overlap with other industries. The British Standards Institution and the committee considering the draft British Standard, on which both the National Computing Centre Ltd and the Department of Trade and Industry are represented, appears to be the most suitable body to pursue this.

4.4.5 The draft British Standard suggests that the Commodity Identification Code is only the first part of the complete commodity record, to be followed eventually by classification and specification codes. Development of these codes under the aegis of the British

Standards Institution and the Department of Trade and Industry presents difficulties. It is possible that code structures will be needed for computer applications in both commodity and project information systems, the code structures for which may be related, if not identical.

4.4.6 It is unlikely that agreement on a national code structure reflecting the classification needs of all industries, compatible also with international codes, will be reached in the foreseeable future having regard to the particular needs of project information in the construction industry. We recommend therefore that, as the classification system for the construction industry is developed, studies should be made of the need for coding and, if required, a notation should be devised to form a code which will classify or signify the properties of commodities used in the construction industry.

4.4.7 In the meantime however we do not wish to see any delay in any area where early implementation can be achieved; we therefore recommend that the British Standards Institution be asked to produce a draft British Standard for a Commodity Identification or Transactions Code for the Construction Industry. This recommendation has been endorsed by the executive of the National Council of Building Material Producers and by the National Federation of Builders' and Plumbers' Merchants. We recognise the possibility of later national or international complications but consider that immediate benefits would outweigh the risk of being compelled to change in the future.

Project information system

4.5 Structuring project information

4.5.1 We consider one of the highest priorities for data co-ordination to be the development of an improved and standardised structure for project information both as an aid to communication and as a basis for rationalisation of the procedures and processes of design and construction. The subject covers a wide field and includes the content and preparation of drawings, specifications, bills of quantities and other documents, their assembly and cross-referencing, and their mode of presentation to all the participants in the total design and build process. In the longer term it will entail work on methods of measurement, libraries of descriptions for bills of quantities and co-ordination of manual and computerised methods of presenting information, described separately in the following paragraphs.

4.5.2 In general the arrangement of project documentation is governed by a heterogeneous set of unrelated conventions which are implicit in text books; knowledge of them is acquired during professional education and experience, and few acquire any legal or institutional status. A number of co-ordinated systems have been developed in recent years, and although many of these share some common features there are many differences and incompatibilities between them. A team of consultants directed by our Secretariat was therefore set up to assess and evaluate the present systems of structuring project information and to develop a model of a system as a basis for co-ordinating their development. The team was also asked to indicate the lines of development needed to make existing systems compatible with each other and with the model, and to indicate what further research or development work might be required.

4.5.3 The team presented its report[9] to us in two parts, in February 1971. It concluded that there is no commitment by the industry to any one system of structuring project information. None of the new systems had been used on more than a pilot scale, although more contracts were in the pipe line, and none stood out sufficiently to be recommended as the framework for future development. Many systems drew upon the CI/SfB notation for those facets where it was thought to be satisfactory. In general new systems had been developed to suit the particular requirements of their sponsors, who had been able to rationalise and resolve their own problems without much difficulty, but had tended to put their own interests first, so that users were receiving information in a form not

primarily devised for them. The team had therefore decided to study the problem from a more fundamental aspect by identifying the requirements and preferences of the users of project information. From this basis a model system could be developed unconstrained by existing systems.

4.5.4 The model project documentation system presented is based on these beliefs. The construction team should have sufficient pre-tender information on which to base an objective decision whether or not to tender. Project information should distinguish between what is final, subject to review, or tentative and be adequate, accurate and available when needed. The construction team should be able to cross-relate information from different parts of the project documentation, and be able to identify the project documentation with the main stages and processes of construction. The task of the design team is to meet these needs subject to the constraints imposed by their own need to operate within the fee structure, to prepare client reports and to provide a sound legal basis for contracts.

4.5.5 A synopsis of the report stating the principles adopted in the model documentation system to meet these needs and the recommendations of the team is given in Appendix 3.

4.5.6 We accept the general approach of the team, and in particular the need for project documentation to be arranged to meet the users' needs. However although existing systems have been used only on a pilot scale, their use is increasing and new developments are taking place. In this situation there seem to us to be three possible lines of action:

a. to do nothing—to allow new developments to evolve without intervention;

b. to recommend thorough development of the proposals made by the team;

c. to encourage the convergence of existing systems by building upon and developing the considerable features they have in common, at the same time drawing upon the new insights and ideas in the team's proposals.

4.5.7 We recommend that of these three the last, c, shows most likelihood of advancing the concept of a common project information system for the construction industry. We believe this to be so precisely because there are considerable common features among existing systems, and because to proceed in this way will offer the best opportunity for collaboration throughout the industry. In bringing the existing systems together their suitability for traditional and non-traditional construction needs to be considered and assessed separately, as must their applicability to differing tendering and contractual procedures.

4.6 Graphic symbols

4.6.1 The signs and symbols used to represent items of plant and equipment etc on drawings, are to drawings what words are to other documents. There is a need for a standard set of symbols used with a single meaning throughout the industry, as part of the syntax for the project information system.

4.6.2 A preliminary study made at our request by Robert Matthew, Johnson-Marshall and Partners, Architects[9] found that different sets of symbols recommended by organisations such as the British Standards Institution, the Institution of Heating and Ventilating Engineers and others were in conflict, in that they recommended either different symbols to represent the same thing or the same symbols to represent two different things. They also found that the relevant British Standards were little used.

4.6.3 We therefore recommended that consultants be appointed to prepare a schedule of the conflicting symbols, in order that we could agree with the authorities concerned on how the conflicts should be resolved, and to prepare a draft publication showing a comprehensive set of the approved symbols and abbreviations. The consultants have examined

the degree to which foreign sources of graphic symbols nearest in character to the British Standards are used in their home countries and, if more widely accepted there, the reasons why. Lastly they have studied the best way to promote widespread use of the new document.

4.6.4 The conflicts between the different sources are now being resolved, and the British Standards Institution has agreed to publish the comprehensive set of approved symbols when completed. We consider it important to ensure that new conflicts do not arise in the future. The majority of conflicts occur between the symbols used by architects and engineers to indicate items of electrical equipment. Services engineers use the symbols recommended by the Institution of Heating and Ventilating Engineers more consistently than members of other professions use the British Standard symbols, and we recommend that close liaison be maintained between the Institution of Heating and Ventilating Engineers and the British Standards Institution to prevent future conflicts. It is also important that the draft British Standard does not inhibit the development of new graphic techniques and the use of computer controlled digital plotters in the industry.

4.6.5 Closely related to the subject of graphic symbols used on drawings is the matter of the notation used by engineers for calculations, data input, and less frequently on drawings, eg the direction and nature of forces, the forces and velocities for hydraulic calculations, factors entering into thermal calculations, etc. There are almost as many different notations as there are text books, computer procedures and design guides. Whilst there is no direct evidence that this amounts to serious confusion, it is interesting that one of the first and most successful attempts at data co-ordination was that by the Computer Committee of the Institution of Structural Engineers which stated a notation for input for structural calculations. Similar conventions could be derived for other engineers' purposes and could be used consistently in text books, codes of practice, design guides and computer procedures, and we recommend that this be done.

4.7 Procedures for briefing, and for local and statutory authority approvals

4.7.1 The work on structuring project information and graphic symbols described in the last two sections is intended to improve project information within the context of existing procedures and the framework provided by 'external' documents, such as the Standard Method of Measurement, which affect the arrangement and presentation of project information. We consider that improvements in procedures and the 'external' documents which form part of the syntax of project information should be made so as to improve co-ordination and integration of the different elements of the system and so improve its efficiency.

4.7.2 At our request a survey has been made of those procedures which are essentially manual to identify areas of possible further development. The results of the survey indicated a need for work to improve the procedures for collecting information for the client's brief and for obtaining local and other statutory authority approvals.

4.7.3 The briefing procedure, by which the designer collects information as to the client's requirements and policy, involves in principle an iterative communication process in which the client describes his requirements and his own constraints to the designer, who in turn submits proposed solutions to the client for decision. It is essential that full information is obtained in a way that can reveal the functional and cost implications of every decision. It is also desirable, so far as possible, that the resulting brief is in a format suitable for input to the subsequent design programmes, including those of consultants and other specialists. We recommend that a study be made to develop a general briefing procedure, taking note of the RIBA Plan of Work, to ensure that at the beginning of each stage of the design process the members of the design team obtain in a suitable form the full information as to the client's policy and needs that they require for that stage.

4.7.4 The subject of building regulations, and the procedure for obtaining the approval of local authorities and statutory bodies generally to the various aspects of a building project, is very complex. It would appear that any future organisation for data co-ordination can be concerned only with developing efficient procedures for seeking and obtaining statutory approvals within the framework of legislation and not with the legislation itself.

4.7.5 The main tasks in this field therefore are the development of efficient systems for retrieval of the statutory requirements relevant to any particular situation; for the requirements to be presented in a form suitable for direct input into design programs; and for the information required at particular stages by statutory authorities to be in a form most suited to their requirements. We understand that the Department of the Environment is considering the possibility of preparing a guide to the legislation relating to design and construction, and we welcome this initiative. We recommend that future work on project information systems should be directed to ensure that information required by statutory authorities, including the calculations on which the submission is based, are in a form that can be checked with the minimum of effort and produced as part of the normal sequence of design activity.

4.8 Project Management Information

4.8.1 We have previously indicated the need for preparing project information in a form suitable for management and control by contractors, and the close relationship between project data and management data. Many industries now recognise that to use computers to their best advantage in management it is necessary to build up a central data bank of management information for each organisation. In the construction industry this task is difficult because of the variety of presentations of project information. We recommend that a study be made of the relationship between the management information needed for project control, and project information, so that project information systems can be developed to yield useful management information for the contractor. The study should also indicate any need for future work on project management information systems taking account of work currently in hand under the Committee on the Application of Computers in the Construction Industry to prepare a contractors' cost control program.

4.9 Standard methods of measurement and standard libraries of BQ descriptions

4.9.1 The BRS Report, which was confined to building, recommended that the present methods of measurement should be reviewed, with particular reference to the relationship of measurement to feedback of productivity. The subsequent report on "Coding and Data Co-ordination in the Civil Engineering Industry" pointed out that revisions to methods of measurement were central to the development of data co-ordination in that field. Our subsequent studies confirm the view that improvements to information flow generally, and to project information in particular, depend upon changes in methods of measurement.

4.9.2 The Royal Institution of Chartered Surveyors and the National Federation of Building Trades Employers have recently agreed to set up a committee to review events leading up to the existing agreement over the Standard Method of Measurement; to examine criticism of the Standard Method of Measurement for Building Work; to take evidence from those in the industry who are involved in and affected by prevailing methods of presenting project data; and to consider the feasibility of extending the concept of standard measurement beyond the tendering process into the realms of production planning and control. Three years ago the Construction Industry Research and Information Association commissioned the University of Manchester Institute of Science and Technology to research into all aspects of the use of bills of quantities in civil engineering, particularly in respect of the integration of bills with the contract programme and simplification of measurement procedure, and the Institution of Civil Engineers has now commissioned the University to revise and update the Civil Engineering Method of Measurement. The former Ministry of Transport has produced its own Standard Method of

Measurement for roads and bridges, drawn from the Civil Engineering Standard Method of Measurement, and the Central Electricity Board has prepared a Method of Measurement for use in its own sphere. A Standard Method of Measurement for use in petrochemical installations is currently being drafted.

4.9.3 We recommend that any future work on revising or preparing standard methods of measurement should take account of the need for data co-ordination. In particular we consider that the revision of methods of measurement and the presentation of bills of quantities should take place in the context of a total project information system so that drawings, bills of quantities and specifications are similarly structured and can be readily cross-referenced, and that the methods of measurement for mechanical and electrical installations should be simplified. So far as possible, having regard to the differing kinds of work for which they are used, the various standard methods should be mutually compatible so that what is substantially the same work is measured in the same way throughout the industry.

4.9.4 There are a number of standard libraries of descriptions of measured items in use or under development by different organisations, mostly based on the Standard Method of Measurement for Building Work. Most of the libraries are of general application but some have been developed for particular systems of building.

4.9.5 We consider that the forthcoming publication of a National Building Specification and the probability of imminent revisions to the Standard Methods of Measurement, which will entail consequential alterations to the standard libraries, open up the possibility of agreement being reached on the development of a single comprehensive standard library of descriptions for bills of quantities. We recommend that a study be made of the feasibility of such a library, linked to both the National Building Specification and to sets of standard working details, to which we refer later, as a means of eliminating much of the repetitive and laborious development and production work now taking place.

4.10 The National Building Specification

4.10.1 In August 1968 the Laing Committee reported to the Economic Development Committee for Building that a National Building Specification would be likely to increase productivity throughout the industry, and that the project was technically and financially feasible. The Economic Development Committee accepted an offer from the Royal Institute of British Architects to act as executive sponsor for the project, and work is now under way for the first edition to appear in mid-1972. The National Building Specification is to be a large library of specification clauses giving alternative descriptions of materials, techniques and conditions for building works. It will therefore act as a central store of standardised general information, sections of which can be readily translated into project information, which will thus become more standardised than has been the case in the past. It will have considerable significance in the field of data co-ordination, for specification impinges upon many spheres of activity. Our respective timetables have unfortunately made full co-ordination of our activities with those of the National Building Specification difficult, but we expect that the terms from the Thesaurus for the Construction Industry will be used in the first edition to some extent. It is unlikely that our work on Classification Categories or on the Structuring of Project Information will be used in the first edition. We were told that CI/SfB has been adopted for arrangement of the National Building Specification partly to provide co-ordination with office libraries and partly to facilitate co-ordination with measured items and drawings by use of coded cross-references.

4.10.2 Specifications are an important part of project documentation and we consider it important that the National Building Specification should be structured in accordance with the general syntax for information systems in the construction industry.

4.11 Library of standard working details

4.11.1 We have mentioned the advantage of linking standard libraries of bill descriptions, the National Building Specification and standard working details. We recommend that a study be made to ascertain the feasibility of establishing a library of sets of standard working details for building work, each detail perhaps having a set of unit quantities as a means of increasing the efficiency of both the design and construction processes. Such a library might be accumulated from details contributed by individual offices.

4.11.2 A Working Group of the Structural Engineering Sub-Committee of the Committee on the Application of Computers in the Construction Industry[10] has recommended the preparation and adoption of a similar comprehensive library of not-to-scale standard engineering details; the actual dimensions to be applied to the standard details for an individual project could be transferred from the computer calculations in a number of different ways. It was intended that initially the library would include only reinforced concrete details, but it might later embrace structural steelwork. The principles underlying the proposals were warmly endorsed by a conference of 160 structural engineers in November 1970, and under a project known as LUCID, sponsored by Professor L L Jones of Loughborough University of Technology, individual offices are now contributing to the preparation of such a library. We endorse this initiative and recommend that close liaison be maintained between the project and the work of data co-ordination to ensure compatibility of standard details with the general project information system.

4.12 Documentation for site investigation

4.12.1 The Freeman Fox Report concluded that soil mechanics, including the activities of site investigations, laboratory testing of soil samples, the analysis of soil stress conditions, and soil stabilisation, was of paramount importance to civil engineers. It considered that there was probably a case for further standardisation of some soils tests and the presentation of results, and that the British Standard Code of Practice (last revised in 1957) should be revised to take account particularly of new survey methods and techniques for soil and rock studies.

4.12.2 We accept these suggestions and recommend that a study be made to identify what information from site investigation, bore hole and soil testing reports will be of use to the industry at large (that is both users and researchers other than the organisation commissioning the borehole or test), and to ensure that presentation of this information lends itself to easy coding for use in manual or computer aided data banks.

The general information system

4.13 Presentation of technical information in trade literature

4.13.1 We turn now from project information to general information starting with the presentation of technical information in trade literature on which the construction industry is heavily dependent for technical data on the materials, components and other commodities it uses. We regard the presentation of this information as part of the syntax of general information, and its standardisation as a first priority to improve the flow of commodity information in the industry.

4.13.2 The Standardisation of Trade Literature is covered by BS 1311, first issued in 1955 and amended in 1958. The British Standard does little more than standardise paper sizes but in its day was a useful step forward. The RIBA, RICS and NFBTE subsequently issued a document "The Preparation of Trade Literature for the Building Industry" which is used to some extent, but we considered that there is need for a British Standard which would enable like products to be readily compared, reduce time in searching for data relating to products, and make technical data in trade literature more readily usable in project documentation. With the agreement of the British Standards Institution Dargan Bullivant Associates were asked to prepare a draft British Standard to meet these objectives.

4.13.3 This [8] has now been prepared. It defines the various types of main documents to be used for trade literature as Single Product Handbooks, Single Product Catalogues, General Catalogues of Products, and General Technical Documents. The first three of these Main Documents are different collations of Part Documents, which are defined as Product Data Sheets; Sample Presentations; Parts Lists; Component Range Lists; Design Data Tables; Application Details; Specifications; Sitework Instructions; Maintenance Instructions; Price Lists and Conditions of Sale; and Quotations and Tender Documents. Technical information under all the Master Headings of the CIB Master List of Properties is to be given in Product Handbooks, Single Product and General Catalogues, and Product Data Sheets, following the sequence of the Master List. Part Documents except Product Data Sheets shall include only information contained under the relevant Master Heading for that Part Document.

4.13.4 Discussions are now being held with the British Standards Institution to arrange for the completion of a small amount of outstanding work and a British Standards Committee is being set up to examine the draft prior to publication.

4.14 Central commodity file

4.14.1 To improve the flow of commodity information the BRS Report recommended a central commodity file containing information on the identification, composition, method of manufacture, properties, appearance, performance, shape, dimensions, weight, application, availability and prices of all materials, products and components used in the industry.

4.14.2 We considered this recommendation and concluded, in view of the obviously high cost of the project, that some measure of the demand for such a file was needed. As a result W S Atkins and Partners, Consulting Engineers, were commissioned to undertake a preliminary fact finding survey of the existing commodity information flow within the construction industry to assess the effectiveness of current commodity information systems.

4.14.3 They reported in May 1970[11] having interviewed 215 members of the industry, including 30 architects, 25 engineers, 16 quantity surveyors, 39 builders, 15 sub-contractors, 43 manufacturers and 17 merchants. Of the users of information, 75% of quantity surveyors, 55% of architects, 50% of engineers, 43% of contractors and 20% of sub-contractors were in favour of the proposal. Of the producers of information 50% of manufacturers and 37% of merchants supported it. Large firms were generally more in favour than small. Users of commodity information reported that searching for information is time consuming, costly and frustrating; price information is difficult to get; trade literature contains insufficient technical information; and it is difficult to select from a range of alternatives. Producers of information reported that producing and distributing catalogues is a major problem; it is difficult to keep information up to date and to ensure that it reaches the right person. The total cost of obtaining and providing product information throughout the construction industry was estimated to be between £50 and £70 million per annum. The consultants considered that a case had been established for a central commodity file.

4.14.4 On the basis of this report W S Atkins and Partners were asked to make a further study to establish the technical feasibility and commercial viability of a central commodity file for the construction industry, by examining alternative systems and determining which would be most favourable in commercial and operational terms.

4.14.5 The consultants reported in February 1971[12] that a number of systems would be technically feasible, but the greatest net benefits (estimated at £10 million per annum) would accrue from a central computer system. Alternatively an in-house microform system would produce net benefits estimated at £5 million per annum. £10 million per annum would represent a saving of the order of 20% of the industry's present expenditure on commodity information. A short summary of the consultants' report is given in Appendix 4.

4.14.6 The two systems have different characteristics. The in-house microform system has greater ability to show the appearance and colour of commodities, but the central computer system is more readily updated and could give better information on price and availability. The estimated cost of developing and appraising a pilot microform system is between £150,000 and £200,000, whereas the estimated cost of developing and appraising a pilot central computer system is £800,000. Alternatively the two could be developed and tested in parallel at an estimated cost of £850,000.

4.14.7 We consider that the ultimate development of a comprehensive commodity file is fundamental to any substantial improvement of information flow, particularly in the light of probable future developments and innovations in the construction industry and our belief in the increasingly important role of computers in the design and construction process. In view of the cost of development and pilot testing, and the technical problems still to be solved, we recommend that the development of the file should take place slowly in a sequence of stages, starting with improvements in the existing system ; pilot development of a computerised or microform system should not commence until a precise definition of contents and usage has been established for the different parts of the total file. It is also important that the development of the file should not impede the existing communication flow between manufacturers and designers.

4.14.8 A number of other initiatives are already being taken both in this country and abroad to improve the flow of commodity information, and in particular central commodity files or similar ideas are being developed in France, Canada and the United States. Liaison already established with this work should be maintained to determine whether or not pilot development should be related to them.

4.15 General information systems and feedback

4.15.1 The construction industry needs and calls upon a great variety of general information. For the most part this information is not arranged, collected, or presented in a form best suited to the needs of the industry, and time is wasted in searching for and assembling information from different sources. Our proposals for a syntax for information systems will, we think, improve the situation in many respects, but more could be done especially to enable the industry to learn from its own previous experience.

4.15.2 Procedures for providing feedback of information to the industry as a whole of the knowledge gained from individual projects are generally poorly developed for a variety of reasons. The difficulties of providing this information on an objective basis taking account of all the circumstances surrounding a project should not be under-estimated. Nevertheless we are of the opinion that the performance of the industry could be substantially improved if the mistakes made on one contract could be avoided on future contracts by disseminating feedback information more quickly throughout the industry.

4.15.3 Feedback information is required from two different sources over two substantially different timescales. First from the contractors, covering the contract period and describing construction difficulties caused by particular types of design, or the results of using new procedures and construction techniques. Secondly from clients covering the first few years of occupation of the works describing the performance of the building in meeting user needs, the performance of materials, of environmental systems and services and of new methods of design and construction, and detailing maintenance costs. It is also essential that both project design and construction planning are based on a sound knowledge of the true cost of the resources likely to be used in the immediate construction of a project. This would require feedback as to the true cost of production resources.

4.15.4 We recommend that a review be made of the effectiveness of existing information feedback procedures and of the need for additional work to develop improved methods in these areas.

4.15.5 In the longer term we consider that studies should be made to investigate the need for and the feasibility of central files for information on the availability and performance of contractors' plant and equipment, the availability of sub-contractors and (in collaboration with the appropriate authority) the availability of labour in particular areas. The possibility of central or regional libraries of site investigation reports (see paragraph 4.12) and of the statutory requirements for different construction situations and geographical locations (see paragraph 4.7.5) could also be considered.

The syntax for computer applications

4.16 Data structures

4.16.1 One of the studies now in progress under the Committee on the Application of Computers in the Construction Industry, relevant to the task of Data Co-ordination, concerns the problem of data structures. When information held in a computer is to be drawn upon for a particular purpose it is a relatively simple matter to store it in the way most suitable for the use to which it is to be put, and no real problem arises. However, when the information is to be drawn upon for a variety of purposes it is unlikely that any one method of storage will be equally suitable for all, and it may be better to store it in a form suitable for compact storage and portability. Information required for different purposes can then be drawn from the store and re-arranged to suit the particular purpose for which it is required.

4.16.2 The work now being undertaken is a fundamental study of data structures for computer storage of information attempting to achieve commonality of the 'core' data structure. As such it has considerable relevance to the information storage problems of a computer based central commodity file and computer aided design systems.

4.16.3 We regard this study as an important step in the development of a syntax for information systems, and we recommend that any future organisation for data co-ordination should maintain close liaison with the work.

4.17 Descriptions of building geometry

4.17.1 A second problem being studied by the Committee on the Application of Computers is that of describing and storing the information relating to the geometry of a building in a computer. Except in one or two rather special cases this problem is being solved separately for each computer applications program. There is no project in hand for developing a standard method, but Cambridge University has been looking into the basis of commonality in current methods and a report is awaited.

4.17.2 We consider that this project is closely related to the data co-ordination work on the structuring of project information and on drawings generally. Any standard methods devised for describing the relationship of parts of the building such as room, wall, or slab numbering systems, or the location of parts by geometrical co-ordinates may well be of benefit in manual as well as computer applications. Manual and computer methods of presenting geometrical information are both likely to be in use for a long time to come and any standard methods should be mutually compatible. We consider therefore that this project also be regarded as part of the development of a syntax for information systems, and we recommend that close liaison be maintained in the future with this work.

4.18 The project file

4.18.1 A third proposal being considered by the Committee on the Application of Computers is the development of a file structure for project information such that all the information relating to an individual project, in its most up-to-date version, would be readily accessible to all those engaged on it. To execute any particular routine the person concerned would access the file for all relevant data, execute the particular task on which he was engaged

and put the results back into the file, cancelling where necessary any superseded data in the file in the process.

4.18.2 This development is closely related to the Working Party's study on the structure of project information, forming part of the syntax of information systems; the Working Party's study deals with the rules or conventions governing the assembly, presentation and cross referencing of project information for manual applications, whereas under the project file development it is proposed to develop a computer file structure for holding project information. We recommend that close liaison be maintained between the two projects.

Other Work

4.19 Rules for operations on data

4.19.1 The BRS Report referred to the acts or operations by which the functions of the industry are discharged as procedures. Thus there are procedures for design and for measurement of buildings, for materials ordering, for project planning and for all the tasks by which a building is designed and constructed including management tasks. At present procedures are executed in many different ways and are only loosely related to each other, causing duplication and waste of effort. The BRS Report recommended that as a prelude to the wider use of computers, more formalised procedures be developed, preferably in related suites, to facilitate data processing and manipulation in data banks.

4.19.2 The Report implicitly equates the development of related suites of procedures to the development of computer programs, which is generally the concern of the Committee on the Application of Computers in the Construction Industry. All of the work of that Committee is relevant to data co-ordination but perhaps the most significant development has been that of GENESYS.[13]

4.19.3 The Committee's Structural Engineering Sub-Committee recommended that there was an immediate need for a generalised software system to control a number of problem-solving sub systems for specific applications. This system would employ standard input and output data formats and would be framed to run on the range of computers likely to be in general use. Individual sub systems could be integrated in any way needed by the engineers, the output from one program being stored for use as input to others. The report suggested that the existence of such a system should encourage engineers to produce new applications software in the form of sub systems which would complement one another and be filed in the GENESYS library for use by all. The recommendation has been implemented, and a consultancy company set up by Loughborough University of Technology has been commissioned to establish and run the GENESYS Centre which will market GENESYS on a commercial basis. It is hoped that it will be possible to extend this particular development of a related suite of procedures to services engineering.

4.19.4 The introduction of operational rules for manipulating and operating on data by the development of related suites of procedures is an important element of data co-ordination and will affect the structure of all information stores. We have already referred to the need to ensure that libraries and information generally are arranged to reflect the needs of users of project information and we stress again that the operations by which the industry can most effectively perform its tasks must not be hindered by the structure of its stores of information.

4.19.5 We consider that the co-ordination of work on procedures should be the concern of any future organisation for data co-ordination but that the Committee on the Application of Computers in the Construction Industry should be responsible for the co-ordination of computer programs. Close links will need to be established and maintained between the two organisations.

4.20 Communication to operatives

4.20.1 Since the BRS Report was published the Building Research Station has continued to work on problems of communications in the construction industry. A study now in progress is investigating communications to operatives and the use made of the project documentation on construction sites. The investigation is programmed to last three years, and results are expected in 1972.

4.20.2 We consider that work of this nature is fundamental and should be continued and extended. Any future organisation for data co-ordination should encourage basic studies especially towards the development of methods of evaluating information systems.

4.21 Overseas developments

4.21.1 The situation described in paragraph 2.9 which led to the need for data co-ordination being recognised in this country is not confined to the United Kingdom. Consequently a great deal of work is currently in hand abroad, with which we have maintained constant liaison in order to benefit from shared research results. In Appendix 5 we describe the main developments in data co-ordination in other countries.

4.21.2 We consider that the need for data co-ordination on an international basis is likely to increase rather than to diminish. The Department of Trade and Industry is already engaged in tripartite discussions with France and West Germany on commodity coding to facilitate trade between the three countries. If the United Kingdom should join the Common Market, pressure for international standardisation of construction regulations and documentation can only increase. The rationalisation of communications internally not only brings substantial benefits of itself but is likely to be an essential preliminary to international standardisation, while the experience gained in implementing a national system will be of immense benefit when the time comes to institute international systems. This question of international co-ordination has an important bearing on the organisation of future work, and we return to the subject later.

5 Implementation

Generally

5.1 We are convinced that data co-ordination will bring substantial benefits both to the industry and to the community and we are concerned that the work should be continued. We are not, however, unaware of the difficulties. The approach of the industry to its problems is essentially a practical one; either a thing works or it doesn't, and scant respect is generally paid to mere theorising. There is thus a need for an equally practical approach to data co-ordination. This often conflicts with the need for fundamental work to be undertaken which may appear "theoretical" to those engaged in practice. For example most practitioners would agree on the need to get information rapidly, cheaply and accurately, but they would pay scant regard to the controlled vocabulary and classification which would enable the need to be met.

5.2 We agree therefore with the BRS Report that progress should be evolutionary rather than revolutionary; that systems should be brought together into a common framework gradually and as benefits are demonstrated. A considerable amount of research and development work is being done by a variety of organisations and research institutions and is shown in Appendix 6. What is lacking is co-ordination. Project information systems are being developed, for example, by RIBA Services Ltd, GLC, DOE (for highways and buildings), DOHSS, LAMSAC and a number of separate local authorities. A Building Cost Information Service and a general information abstracting service have been operated by the RICS for a number of years. Some, but not all, of these use parts of the CI/SfB classification developed and administered by RIBA Services Ltd, but add to it in different ways.

5.3 We have noted the wide range of activity in this field by RIBA Services Ltd. It includes work on classification through CI/SfB, the next revision of which will contain implicitly or explicitly a thesaurus of terms; a commodity information service of product data sheets, shortly to be launched; a manual of project information, already published; a general information abstracting service which, subject to the availability of finance, will be commenced; and the National Building Specification which is being prepared with assistance from the Department of the Environment and the Greater London Council. We have already recommended that the possibility of the RIBA transferring its licence to develop, promote and administer SfB to a broader group of industry interests or to a central body be explored, but whether the licence is transferred or not, we consider that there is a need to study the convergence of the Study Team's proposals on classification and CI/SfB as noted in paragraph 4.3.8.

5.4 The aim of future activity must be to develop a sound and relatively unchanging foundation in the form of the syntax, on which can be constructed a framework readily adaptable to different situations. A difficulty is that the benefits obtained depend on widespread acceptance of the framework; if a substantial sector of the industry refuses to accept parts of it, information flow will be impeded and costs will exceed benefits. The problem can be overcome if the industry is as convinced as we are that the results will be worth the effort, and that over a total system there is likely to be a benefit for all. Money is already being spent from private sector sources and in public sector design offices in improving information flow; our proposals would lead to an increase in the benefit from this expenditure by co-ordinating these activities.

5.5 The position of the existing information services of the industry—the Building Centres and the commercial information services, the journals and the professional institutions—needs to be considered. We believe that there is nothing in any of our proposals which will not, on balance, bring benefits to this sector of the industry. There is a need for information, and the need will grow. If the UK enters the EEC there is likely to be an increase in the information which the industry needs to handle and there will certainly be benefits to be obtained from an efficient information service aimed at Europe. We propose means by which information needs can be met more efficiently. Efficient sources

of information can use these methods to improve and extend their services. We consider that when information can be obtained more readily, more will be sought, and that the existing information services can benefit from the growth in the demand for information. The organisation we discuss below makes specific provision for commercial information services.

5.6 Finally we return to the question of international co-operation. We think that this is another growth point in the information system for the construction industry. There will be a need in the future for the United Kingdom construction industry to speak with one voice in international councils dealing with such matters as commodity coding, regulations and standards and their presentation, and project documentation. This means that any future organisation for data co-ordination must be representative of an authoritative cross section of industry interests.

The organisation for implementation

5.7 We are asked in our terms of reference to make recommendations for implementation. This has not proved an easy task. It should be said at the outset that a few members of the Working Party have considerable reservations, both as to the desirability and the practicability of the organisation proposed below. We are however, agreed that these proposals should be published for discussion by the industry.

5.8 It is of the greatest importance that new developments to improve information flow be brought into practical use. Some organisation or body must be formed, therefore, with the specific task of testing new developments and bringing them into general use. This body must have responsibility for a substantial flow of construction work, have an incentive to finance the programme of research and development necessary to evolve the syntax or co-ordinating rules, and be orientated towards application.

5.9 The benefits of an improved information system accrue to all users of the system; all members of the design and construction teams benefit from the saving of time made possible by the improved quality and quantity of information, and in the long run the client benefits from the better service he receives. The appropriate body to implement our recommendations is therefore some association of users, consisting of building departments with large and continuing programmes of construction work, and other members of the industry who wish to improve their service to their clients. Such a body would have the incentive to develop improved methods since the members would reap the benefit of successful innovation on their own programmes of work.

5.10 It is envisaged that such an association would have three different kinds of members:

(i) Large building departments and design organisations who will be concerned with the total programme and will contribute fully.

(ii) Organisations who wish to be concerned only with particular parts of the programme. For example, design offices may be prepared to develop and test particular aspects of the project information system, but not wish to contribute towards the development of the common syntax, although they would, of course, undertake to use it.

(iii) Organisations who are concerned with the total programme, but only in relation to a particular sector of the industry. For example manufacturers may be prepared to work on all aspects of the system from classification to coding and project information, but only to the extent that manufacturing interests are involved.

5.11 It is assumed that the members of the association will act in a managerial role, delegating the day to day work to a Working Group staffed or financed by them. This Working Group should comprise a small nucleus of staff, and should undertake little, if any, development itself. Its task would be to co-ordinate the activities of members, and as far as possible non-members, in the development and testing of the information system proposed, and to commission from consultants and research institutions any studies necessary to support the programme.

5.12 It is also proposed that an Advisory Committee be formed from representatives of the industry's major institutions. This would be an advisory body only, since the members of the Association could not surrender to an outside body their financial and legal responsibilities. Nevertheless the Committee would have an important function and its advice would correspondingly carry great weight. It would bring to the notice of the association and its working group the needs of the industry and advise on research and development required. When development and testing had been completed it would help to publish and give effect to the results. It is suggested that this Advisory Committee might well take the form of a Standing Consultative Committee of the National Consultative Council.

5.13 The recommendations made for future work fall into three sets:

(i) Syntax development and work of a specialised character outside the range of traditional construction skills. This work is not likely to be financially self supporting except in the context of the system as a whole and includes the preferred vocabulary, classification categories, coding, graphic symbols, and the notation used by engineers in their calculations.

(ii) Work which calls on the more usually available skills of the industry since it is of direct application to building projects. It includes structuring project information, briefing procedures, feedback procedures, statutory and other approvals, site investigation reports, Standard Methods of Measurement and standard libraries of bill of quantities descriptions.

(iii) Work which might show a direct financial return to its sponsors (as distinct from system users generally) and is therefore capable of development by commercial organisations. It includes the commodity file, standard working details, etc.

5.14 The task of the Working Group will differ for each of these three sets. For the development of the syntax it will need to sponsor and finance research groups or consultants, and to co-ordinate their activities. The results of the work must then be tested in live situations, as noted below.

5.15 The work in the second set is mainly concerned with the project information system. Here the members of the association will be involved in developing and testing parts of the system and applying them to projects in their own offices. The role of the Working Group will be to co-ordinate activity, to ensure that the syntax is brought into use, correctly applied and adequately tested on live projects, and to feed back the results into the further development of the syntax as necessary.

5.16 The Working Group's role in the third set of activities will be small, and largely concerned with co-ordination and securing application of the syntax. It is suggested that this can be achieved because the commercial organisations concerned will be encouraged to base their services on the use of the common syntax in order to reap the reward which will come from the large and assured market for their services provided by the members of the association.

5.17 The results of successful development would need to be disseminated throughout the rest of the industry. This can be done in several ways:

(a) Much of the design and design realisation work of the major building departments is executed by consultants; the work of the association as a whole would have a wide geographical spread and involve both contractors and manufacturers. Once new methods had been tested and found satisfactory they could be widely used on contracts for suitable projects. Manuals and procedural instructions could be issued to consultants and others for this purpose and in this way knowledge of the new methods would be disseminated quickly.

(b) Where suitable the results of development work could be incorporated in draft British Standards and submitted to the British Standards Institution. The industry as a whole, through its representatives on British Standards Committees, would be able to comment on and if necessary amend the draft before it was finally published for general use. Similarly the many Research Associations in the industry would be involved in many aspects of the work and would help to publicise the results.

(c) Some of the developments, such as improvements in the commodity information system, would probably be made by commercial firms. The association would provide an assured market for such activity and thus endeavour to co-ordinate so as to improve its relationship to the rest of the information system. Moreover the association would perhaps finance some research where it was in their own interest to do so. Improvements in this commercial sphere of activity would be available to the whole industry.

5.18 The totality of these proposals is indicated in Figure 5, which shows a model of the organisational structure we recommend be adopted for implementation. Many of the activities shown under "Commercial Developments" are ongoing activities and nothing we propose envisages that they should be stopped. We are concerned only to provide framework within which they can be supported and made more effective.

5.19 The time to start to implement data co-ordination is now. Throughout the industry there is a growing realisation of the inadequacy of existing information systems. Work is taking place in a number of directions, some convergent, some divergent. Firms and organisations are developing their own systems. Unless the task of co-ordination is started soon the investment in these new systems will inhibit co-ordination in the future. We most strongly advocate early action on the recommendations summarised in section 6 of this Report.

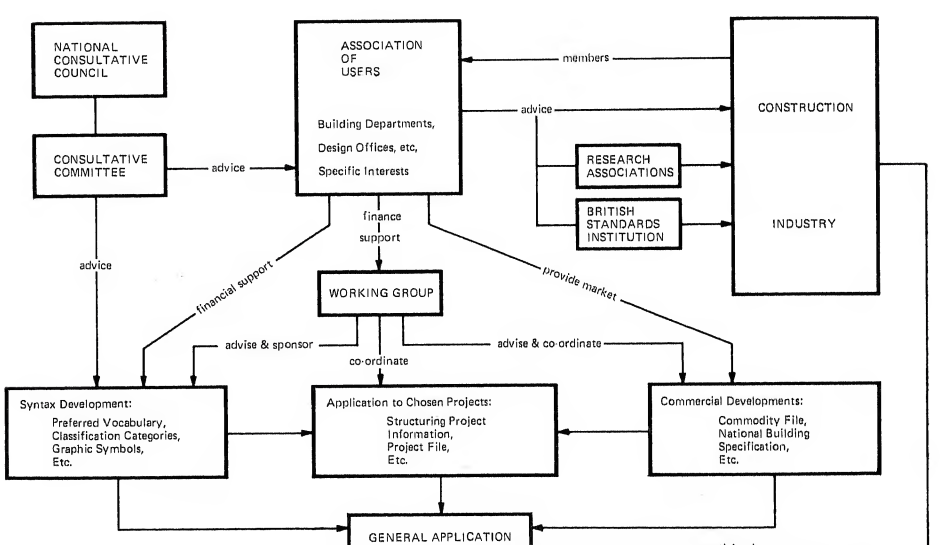

Figure 5 WPDC—Proposed Implementation

6 Summary of Recommendations

Costs and benefits

Each major project to improve information flow should be subjected to a detailed cost benefit analysis before implementation. (*Para 2.12*)

Thesaurus

The Thesaurus for the Construction Industry should be tested in libraries in the industry both to ascertain its performance as an indexing language and to expand the coverage of terms included, and so to correct the present imbalances. Consequent upon the results of the tests a revised edition should be prepared and published for general use throughout the industry. (*Para 4.2.7*)

Glossary

A glossary of terms for use in communication should be prepared, based partly upon the Thesaurus for the Construction Industry and partly on glossaries published by the British Standards Institution and other organisations. (*Para 4.2.8*)

Classification categories

Operational classification categories or sets drawn from fundamental categories should be developed by agreement between individual organisations; the fundamental categories should be based on the classification developed in the Thesaurus for the Construction Industry. The possibility of the RIBA sharing its license to 'develop, promote and administer' SfB with a broader group of industry interests or transferring it to a suitable central organisation, subject to satisfactory arrangement to ensure the interests of present users of CI/SfB, should be further explored. (*Para 4.3.8*)

Coding

As the classification system for information in the construction industry is developed studies should be made of the need for coding, and if required, a notation should be devised to form a code which will classify or signify the properties of commodities used in the construction industry. (*Para 4.4.6*)

Commodity code

Following the Report of the Study Team on Commodity Identification, the British Standards Institution should be asked to produce a draft British Standard for a Commodity Identification or Transactions Code for the Construction Industry. (*Para 4.4.7*)

Convergence of project information systems

The concept of a common project information system for the construction industry should be encouraged by fostering the convergence of existing systems, building upon and developing the considerable features they have in common and at the same time drawing upon the new insights and ideas contained in the proposals of the Team on Structuring Project Information. (*Para 4.5.7*)

Graphic symbols

Close liaison should be maintained between the Institution of Heating and Ventilating Engineers and the British Standards Institution to prevent future conflicts between recommendations for their use when the work in hand to resolve existing conflicts has been completed. (*Para 4.6.4*)

Engineers' notation

Conventions should be derived for the notation used by engineers in text books, codes of practice, design guides and computer procedures similar to the notation for structural calculations prepared by the Computer Committee of the Institution of Structural Engineers. (*Para 4.6.5*)

Briefing procedures

A study should be made to develop a general briefing procedure, taking note of the RIBA Plan of Work, to ensure that at the beginning of each stage of the design process the members of the design team obtain in a suitable form the full information as to the client's policy and needs that they require for that stage. (*Para 4.7.3*)

Statutory & local authority approvals

Future work on project information systems should be directed to ensure that information required by statutory authorities, including the calculations on which the submission is based, are in a form that can be checked with the minimum of effort and produced as part of the normal sequence of design activity. (*Para 4.7.5*)

Relationship of project and management information

A study should be made of the relationship between the management information needed for project control, and project information, so that project information systems can be developed to yield the maximum management information for the contractor and to indicate any need for future work on project management information systems. (*Para 4.8.1*)

Revision of standard methods of measurement

Any future work on revising or preparing standard methods of measurement should take account of the need for data co-ordination. (*Para 4.9.3.*)

Standard library of descriptions of measured items

A study should be made of the feasibility of a single comprehensive standard library of descriptions for bills of quantities, linked both to the National Building Specification and to sets of standard working details. (*Para 4.9.5*)

Standard working details

A study should be made to ascertain the feasibility of establishing a library of sets of standard working details for building work, each detail perhaps having a set of unit quantities as a means of increasing the efficiency of both the design and construction processes. (*Para 4.11.1*)

Close liaison should be maintained between the LUCID project and data co-ordination to ensure compatibility of standard details with the general project information system. (*Para 4.11.2*)

Site investigation reports

A study should be made to identify what information from site investigation, bore hole and soil testing reports will be of use to the industry at large (that is both users and researchers other than the organisation commissioning the bore hole or test), and to ensure that presentation of this information lends itself to easy coding for use in manual or computer aided data banks. (*Para 4.12.2*)

Commodity file

The development of a comprehensive commodity file should take place slowly in a sequence of stages, starting with improvements in the existing system; pilot development of a computerised or microform system should not commence until a precise definition of contents and usage has been established for the different parts of the total file. (*Para 4.14.7*)

Feedback

A review should be made of the effectiveness of existing information feedback procedures and of the need for additional work to develop improved methods in these areas. (*Para 4.15.4*)

Computer applications

Any future organisation for data co-ordination should maintain close liaison with the work now being undertaken under the auspices of the Committee on the Application of Computers in the Construction Industry on the fundamental study of data structures for computer storage of information (*Para 4.16.3*), the problem of describing and storing the information relating to the geometry of a building in a computer (*Para 4.17.2*), and the development of a project file. (*Para 4.18.2*)

Table of References

1 **The BRS Report**
"A Study of Coding and Data Co-ordination for the Construction Industry"—HMSO SBN 11.670197:8 £1.00

The recommendations of the BRS Report are also embodied in a paper entitled "Coding and Data Co-ordination, A Short Report": prepared by the Committee on the Application of Computers in the Construction Industry: HMSO, 1969. SBN 11.670220:6 20p.

2 **"Coding and Data Co-ordination in the Civil Engineering Industry":** Freeman, Fox and Partners, June 1969. Published in a condensed form as an R & D Paper entitled "Data Co-ordination in the Civil Engineering Industry."*

3 **"Thesaurus for the Construction Industry":** North Western Polytechnic School of Librarianship and the Brixton School of Building, November 1970. In course of publication.

4 **"Construction Indexing Manual"**—RIBA, 1968. £3.75.

5 **"Report of the Study Team on Classification Categories",** July 1970. In course of publication in an edited version.

6 **"Information Systems relating to the Construction Industry":** A Gilchrist and Kathleen Gaster of ASLIB: Building Research Station Current Paper—CP 11/69.*

7 **"Report of the Study Team on Commodity Identification",** November 1969. Published in a condensed form as an R & D Paper entitled "A Commodity Identification Code for the Construction Industry".*

8 **"Draft British Standard Specification for Commodity Coding: 70/10431".** British Standards Institution, 2 Park Street, London W1.

9 **Study on Structuring Project Information—Report of the Study Group,** January 1971. In course of publication in a condensed form.

10 **"Communication from Designer to Site—Computers in Structural Engineering":** R & D Paper.*

11 **"Commodity Information in the Construction Industry—A Survey of Supply and Demand":** W S Atkins and Partners, April 1970. In course of publication in a condensed form.

12 **"Commodity Information in the Construction Industry: Feasibility Study":** W S Atkins and Partners, January 1971. In course of publication in a condensed form.

13 **"GENESYS—A Computer System for Structural Engineers and Others",** January 1971. R & D Paper.*

A full bibliography of works on Data Co-ordination is being prepared and will be published in the Bibliography Series issued by the Library of the Department of the Environment, Lambeth Bridge House, Albert Embankment, London SE1.

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*Obtainable free of charge from the Building Information Room, Department of the Environment, Thames House (South), Millbank, London, SW1.

Appendix 1

Terms of reference of studies made by study teams and consultants; Membership of study teams; Consultants

1 Studies carried out by Study Teams

a. Study Team on Classification Categories

Terms of Reference:

To consider the proposals for classification categories, to identify any further categories which may be needed, to advise as to the measures necessary to implement the proposals, taking into account the Working Party's own terms of reference regarding industrial co-operation and compatibility and to report to the Working Party with recommendations.

Membership of Study Team:	Representing:
Professor L Fletcher FRICS FIArb (Team Leader)	Royal Institution of Chartered Surveyors
Mr M J Barclay BA FICE MInstHE	Institution of Civil Engineers, Institution of Structural Engineers and Association of Consulting Engineers
Mr E N Bays	Institution of Electrical Engineers
Mr A Gilchrist AIA MIOM AIInfSc	Association of Special Libraries and Information Bureaux
Mr B E Kimber LIOB	National Federation of Building Trades Employers
Mr W McCann BA BArch	Royal Institute of British Architects
Mr C Read	(Personal Capacity)
Mr M J Roberts	Brixton School of Building
Mr R E Tully CEng FIMechE FIHVE	Institution of Mechanical Engineers
Mr R Watts	Federation of Associations of Specialists and Sub-contractors
Mr B C Edgill ARICS (Secretary)	Directorate General of Development (Housing and Construction), Department of the Environment

b. Study Team on Commodity Identification

Terms of Reference:

To consider proposals for commodity coding for identification purposes, to advise as to the measures necessary to implement the proposals taking into account the Working Party's own terms of reference regarding industrial co-operation and compatibility and to report to the Working Party with recommendations.

Membership of Study Team:	**Representing:**
Mr R Geary AIOB (Team Leader)	National Federation of Building Trades Employers, Federation of Associations of Specialists and Sub-contractors
Mr J M Connor	National Computing Centre Ltd
Mr B C Edgill ARICS	Department of the Environment
Dr O P Hansom BSc CEng MIMechE FIMH	Timber Trade Federation (UK)
Mr R Hermon BSc FICE	National Council of Building Material Producers
Mr D A Reffold	Electrical Wholesalers' Federation
Mr A W Seeley	National Federation of Builders' and Plumbers' Merchants
Mr R F W Malthouse ARICS (Secretary 1969)	Department of the Environment, Directorate of Research and Information
Miss S M Price MBE (Secretary 1970)	

2 Studies carried out by Consultants

a. Data Co-ordination in Civil Engineering

Terms of Reference:

To study the extent to which the criteria and recommendations of the Report of the BRS Study Team on Coding and Data Co-ordination are relevant to civil engineering.

This will involve the following tasks:

i. Study information flow in the design and execution of civil engineering work, prepare (as necessary) alternative or additional procedures to those already included in the Report and test them by consultation with industry.

ii. Investigate and report on current developments in coding and data co-ordination in civil engineering, particularly with regard to the application of computers, which are not already covered in the BRS Report.

iii. Define the areas where a common system of coding and data co-ordination would be possible and desirable for both building and civil engineering. Define also the areas where agreed systems of coding and data co-ordination for civil engineering work are required but where these need not be developed as an integral part of a common building and civil engineering coding and data co-ordination system.

iv. Propose such amendments and additions to the criteria and recommendations (over and above those in the Report) in regard to coding and data co-ordination as will enable computer-processed information to be used more effectively in the design and execution of civil engineering work.

v. Advise on implementation.

Consultants:

Messrs Freeman Fox and Partners.

b. Costs and Benefits of Data Co-ordination

Terms of Reference:

To study the economic performance of the information system currently operating in the construction industry with a view to assessing the cost and effectiveness of the existing system; to ascertain as far as is possible the costs and benefits of implementing a co-ordinated system and the pattern of distribution of the costs and benefits—by industry sector and other parts of the community, by components of the information system, and by time periods over a realistic time scale for implementation; to advise on the marketing aspects of data co-ordination with particular reference to the preferred vocabulary and commodity identification; and to present data which will enable the most effective strategy for future work to be determined.

Consultants:

PA Management Consultants Ltd.

c. Preferred Vocabulary

Terms of Reference:

To produce a comprehensive vocabulary of the terms used in the construction industry organised in such a way that any number of specialist vocabularies can be extracted and developed whilst maintaining compatibility with each other.

Consultants:

North Western Polytechnic/Brixton School of Building.

d. Structuring of Project Information

Terms of Reference:

a) To assess and evaluate the present systems of structuring project information.

b) To develop a model of a system as a basis for co-ordinating the development of systems so as to minimise total cost to the industry of communicating project information.

c) To indicate the lines of development which might be followed to make the existing systems compatible with each other and with the model.

d) To indicate the nature and extent of any further research or development work required which is not at present being undertaken.

e) To report.

Membership of Team:	**Organisation:**
Mr D H Thorne FRAIA FRIBA (Team Leader)	Department of the Environment
Dr D J O Ferry FRICS FIQS MBCS	Southampton University
Mr M V Harries BArch ARIBA	Alex Gordon and Partners
Mr. L N Johnston DA ARIBA MIRAI AMBIM	An Foras Forbartha
Mr M McCann FIHVE MConsE	McCann and Partners
Mr P F Miller AIOB MFB	(Personal Capacity)
Mr E M O'Leary BE CEng FICE	Veryard and Partners

e. Graphic Symbols

Terms of Reference:

Phase I

a) To survey existing sources of conventions.
These will include relevant British Standards and other published recommendations for production documents which have some degree of acceptance in the industry, and will include overseas recommendations where these are relevant to the situation in this country.

b) To make a detailed survey and comparison of significant conventions.
In consultation with the Department, conventions will be selected from the above sources and then abstracted in a manner which permits comparison to determine where they are in conflict.

c) To survey usage.
It will be necessary to assess the extent to which the conventions are used in practice and, where they are not, the reasons for their non-acceptance. It is envisaged that a sample of the production documents entering representative offices will be examined to find the extent of deviation from the relevant conventions.

d) To make recommendations for work in Phase II for completion in draft form by July 1970. The recommendations will include proposals for longer term work and work for action by other sponsors.

Phase II

a) To prepare a comprehensive set of graphic symbols and abbreviations which are normally in the control of the draughtsman, including those currently used by all sectors of the construction and civil engineering industries, including landscape architecture. The possibility of using symbols for the layout of contractors' and other building plant will also be considered in the survey. Such matters as the layout of title blocks and paper sizes, which are normally a matter of office policy, are not included.

b) To prepare a schedule showing the cases in which symbols recommended by different authorities are in conflict, and to show the symbols recommended by each authority. The schedule will be prepared in sections to an agreed classification, and each section will be submitted to the Department for resolution of the conflicts.

c) When the conflicts have been resolved, to prepare a document containing the comprehensive set of symbols. The document will contain a manuscript of the text, typical page layouts, type face specifications and drawn symbols sufficient to allow a printer to prepare plates for a final printing.

d) To make recommendations as to the ways in which the document can be tested for suitability in use and the means by which its use can be promoted. To study, so far as the budget allows and with the minimum of foreign travel, the extent to which similar Swedish and American documents are used in practice. To study and report on the reasons, if any, why such documents are more often used in those countries than in the United Kingdom.

Consultants:

Robert Matthew, Johnson-Marshall and Partners.

f. Standardisation of Trade Literature

Terms of Reference:

a. To study the relevant publications on the subject of technical data in manufacturers' trade and technical literature.

b. To consult with the bodies responsible for the publications and with successful competitors in the Building Centre Trade Literature competition; to ascertain the requirements of designers, quantity surveyors, contractors and specialist subcontractors for technical data, and the views of manufacturers on its inclusion in their trade literature.

c. To consider the use made of trade literature in project documentation and the ways in which technical data, fixing and assembly information etc in manufacturers' literature might be presented so as to be suitable for direct incorporation into project documentation.

d. To consult with BSI to establish the form which the draft should take.

e. To prepare a draft BS covering the content and presentation of technical data and information in manufacturers' trade and technical literature.

f. After the draft has been approved by the Working Party on Data Co-ordination, to serve on the BSI Technical Committee to review comments and agree the final draft.

Consultants:

Dargan Bullivant Associates.

g. Central Commodity File

Terms of Reference:

Phase I

a. To undertake a fact finding survey of the flow of existing information within the construction industry in order to determine the form, effectiveness and shortcomings of current commodity information systems for all major sections of the industry.

b. To establish if a commodity file is wanted by the industry and what information it could contain.

Phase II-IV

a. To establish the technical feasibility and commercial viability of a central commodity file for the construction industry, by examining the possible alternative systems and determining which of these systems appears most favourable in commercial and operational terms.

b. If a commodity file is feasible and commercially viable, to determine its optimum form and content, bearing in mind its potential for future development, and to put forward proposals for an implementation programme.

c. If a commodity file is not feasible or not commercially viable, to define in the light of experience gained during the study alternative means by which the availability of commodity information to the industry can be improved.

Consultants:

W S Atkins and Partners.

Appendix 2

Summary of Report on Costs and Benefits of Data Co-ordination

PA Management Consultants Ltd were asked to make a study of the costs and benefits of data co-ordination in the construction industry, with the terms of reference set out in Appendix 1.

The Consultants proposed to draw up matrices showing, in relative magnitude only initially, the distribution of the costs and benefits for each component of the data co-ordination framework among the different sectors of the industry, in order to determine the significant components of the framework and sectors of the industry. The matrices were to be tested and revised, and the costs and benefits quantified on the basis of sample interviews with members of the industry, during which the degree of probable acceptance of the proposals would also be assessed. The consultants were then to investigate the time scale for implementation of the data co-ordination proposals and to recommend a strategy for implementation.

The original intention was to interview about 200 organisations within the industry to ascertain the level of potential costs and benefits. During the course of the study it became apparent that the conclusions drawn from a smaller number of interviews were unlikely to be amended by interviewing on a wider front, and that more investigations should be made of depots of existing data. It was decided therefore to divert attention to the examination of available data germane to the study, and to discontinue the marketing aspects of the original proposals.

The interviews showed that builders and contractors thought that data co-ordination in the industry would produce savings because of reduced time in resolving design queries; improved pre-planning and contract planning; reduced overheads; fewer errors in ordering and less misuse of materials; less disruption of labour and plant through greater continuity of work; fewer variations and claims; and less abortive work.

Architects, quantity surveyors and consulting engineers considered that savings could arise from less time being spent in retrieving, handling and processing technical and project information; the encouragement of a 'design team' concept by the development of a project file; less abortive work and variations by the provision of an improved design brief; less time being spent preparing bills of quantities, specifications and other contract documents; and less duplication of effort by, for example, the greater use of standard drawing details.

Manufacturers were doubtful whether improved data co-ordination would result in more than a marginal benefit, but thought that benefits would arise from reduced cost of giving quotations; reduced clerical work; improved stock and production control; and reduced marketing costs.

An investigation was made into the costs and benefits of improving information flow in other industries where developments were known to have taken place, and in other countries. It was found that the US National Library of Medicine had created a Medical Literature and Retrieval System (MEDLARS) to process records of scientific papers in medicine and related areas of biology, but the cost effectiveness of the system had not been measured as the need for such a service was clearly evident. Similarly the Shell International Petroleum Company has developed a system for its particular needs, and whilst cost and benefit figures are not available it is known that "considerable economies in money and manpower have been achieved". Information on costs was also obtained from a variety of other sources including the Road Research Laboratory and the Building Research Station, both of which have developed information retrieval systems.

The estimated costs and benefits arising from data co-ordination are summarised in the following tables:

i) Sector Benefits (in £ million per annum)

Sector of Industry	Ultimate Potential Saving
Builders and Contractors (New Work)	88
Repairs and Maintenance (Contract Work)	23
Direct Labour	16
Architects	7
Quantity Surveyors	3
Consulting Engineers	3

Total Community Direct Benefit £140 million per annum.

Manufacturers	4
Merchants	2

Total 'Material Sales' Benefit £6 million per annum.

ii) Component Benefits and Costs (in £ million per annum)

Component of System	Ultimate Potential Saving	Initial Costs	Costs after 15 years
Project Documentation and Project Procedures	58	0·5	0·2
Central Commodity File Preferred Vocabulary Classification Categories Commodity Code	56	11·2	4·2
Graphic Symbols Standardisation of Trade Literature Civil Engineering (including Soil Mechanics)	5 22 5	0·6	0·1
TOTALS	146	12·3	4·5

iii) **Indirect Benefits.** In addition to the Total Community Direct Benefit, additional indirect benefits are likely to accrue through a reduction in the total time taken to complete construction projects. These are estimated to amount to £20 million per annum ultimately.

The main conclusions of the report are:

i) There has been a growing awareness of the importance of improved communication throughout the construction industry but the need has not yet crystallised.

ii) Any attempt to improve communications must be based upon a common framework ie vocabularies, codes, classification categories.

iii) Close collaboration with the industry at large is essential; the implementation of the Working Party's proposals must be on a step-by-step basis and using a down-to-earth approach. Even so, full acceptance must be regarded as long term and is unlikely to be attained in less than 10-15 years.

iv) The greatest benefit envisaged is likely to be through improved project documentation and procedures.

v) Manufacturers and merchants do not envisage any great benefit: such benefit as will accrue should assist them to maintain current profitability in the light of reduced demand for materials.

Appendix 3

Summary of Report on Structuring Project Information

Following a survey of the conventions used in the construction industry, a team of consultants was asked to study the structuring of project information—the methods by which drawings, bills of quantities and specifications are arranged and cross referenced. The terms of reference of the study are given in Appendix 1.

The team concentrated its attention on the typical lump sum competitive tender contract for building work and attempted to identify the needs of the users of information, generally the contractors, and of the producers of project information who are in general the professions making up the design team. They concluded that users needed:

(a) to have full pre-tender information to allow an objective decision on whether or not to tender for a project;

(b) to have adequate and accurate project information at the time it is needed;

(c) to know the completeness of the information and when outstanding information will be available;

(d) to know whether information is final, subject to review, or tentative;

(e) to be able to cross reference the various sources of information in the project documentation;

(f) to be able to identify the project documentation with the main stages of construction;

(g) to be able to identify the project documentation with the various processes of construction;

(h) to be able to derive resource requirements for construction purposes for estimating, planning, organisation and control.

Producers of information needed to have a documentation system which would:

(a) encourage the provision of complete and accurate information at contract stage;

(b) encourage efficient organisation of the design process and integration of the design team;

(c) be practicable to operate within the fee structure;

(d) facilitate the preparation of client reports;

(e) form a sound legal basis for the contract.

The systems of structuring project information being developed and used in the industry were studied, and it was found that most building work is still carried out by each party using its own traditional documentation. Any rationalised and co-ordinated data systems which improve the quality and completeness of the information which the contractor receives are welcomed by him, and there is no commitment by the industry to any one system of data co-ordination.

None of the new systems has been used on more than a pilot scale, and contractors have found it difficult to evaluate them; they have generally been unable to separate the implications of a classification or coding system from the other unusual aspects of pilot schemes, such as being given information which is fully worked out, metrication, etc. There is evidence however, that the role of coding in project information has been overemphasised in the early development of some systems. The new systems have not reached a stage of development where valid conclusions can be reached about the cost of using them.

Most of the new systems which were examined had been used for the documentation of

projects which had actually been built, and to this extent at least were successful. They all had good points but, although some suited the needs of their particular sponsors very well, none of them was thought to be a suitable basis for documenting and managing a project in a way which would be sensitive to the real priorities of the parties without superimposing its own priorities upon them.

It was considered that if today's best practice in the traditional presentation of information could become normal practice within the next five years, this alone would be an improvement of immense significance, and a model for a project information system was developed. The model tries to meet the needs of the various parties, and was evolved from well tried current practices whilst drawing upon the experience of the newer systems. It is intended to be used to achieve a consistent documentation from any design team as an aid to the production of a well integrated design and to suggest procedures that, while representing only a modest but realistic step forward, will not inhibit future development towards greater sophistication.

The principles recommended to be adopted on the structuring of project information are as follows:

(a) The primary objective is the timely and economic communication of immediately usable information. Secondary objectives are the effective retrieval of information by each user, and the correlation of information relating to performance and records of actual performance, such as costs.

(b) The content and terminology of the structure must draw upon current and familiar usage wherever possible. The structure is concerned with the re-arrangement, sorting and grouping of the information currently produced by traditional methods; changes to the nature of some of the information which are suggested by the structuring are a separate consideration.

(c) The structure must be useful both to those parties functioning traditionally and to those using formalised plans of work.

(d) Where the structure logically requires additional information to that likely to be currently available, this should be identified for separate consideration.

(e) The structure must deal effectively with all the information, and is only concerned with information communicated between the parties via documents.

(f) The structure must be independent of the particular structure of any particular document, (such as SMM order for Bills of Quantities), and the application of the structure to particular documents must be sensible, logical and preferable to the traditional structure.

(g) The information presented at any one time must be limited to that required by the user at that time (eg only major contractual conditions when inviting tenders).

(h) The information related to a specific topic must all be presented together, (eg financial details for valuation and cash flow calculations).

(i) The information may be re-stated if it relates to more than one topic or if the re-statement obviates a routine search. The re-statement may be in full or by way of cross-referenced indexes.

(j) The presentation of the information in large general groups is of considerable value.

(k) Techniques of presentation such as drawing techniques must be variable to suit the demands of the project.

(l) The structured documentation system must enable each activity (eg designing, estimating) to be accurately identified and programmed.

(m) The fact of communication via project documentation or by reference to other documents (eg British Standards) must be registered and controlled by both the producer and the user of the documents.

(n) Where firm information is not available this must be stated.

(o) Where useful preliminary information is available this must be given and described as such. It must however, be supported by a statement of when the firm information will replace it.

(p) Revisions must be dealt with economically and exhaustively and the appropriate new documents cross referenced and registered in a manner least likely to promote error in use.

(q) The attaching of codes to items of information is necessary when further sortations of the items, or subsequent data associated with them, are required and the code will facilitate this. Proposals for general use of anything other than simple elementary codes, which suffice for everyday needs, will be unwelcome.

(r) Appropriate basic classifications related to current practice and everyday needs are required; those drawn from esoteric classification considerations are not.

(s) The final system of classification and codes must permit adequate expression of all relevant concepts—design element, construction planning unit and so on.

(t) Constraints on clarity or sense due to notational patterns is unacceptable (eg 0-9, A-Z strait-jackets on groups of classification which should ideally contain say 12 or 30 items).

(u) Retrieval by way of logical and understandable search patterns is essential. Search patterns to suit both designers and users are necessary, and documents and/or information codes must facilitate all the required search patterns.

(v) There is a need to identify the problem solving cycle during design in a way that is meaningful to the practitioner.

(w) The structure must permit detail design to develop at the same time as the scheme design.

(x) The documentation system must facilitate the production of client reports.

(y) The documentation structure should facilitate the introduction of standard design solutions at all stages of the design process.

The model documentation proposed to meet these principles is based on the design sequence Evaluation, Consolidation for client approval, Development, Consolidation for client approval, Production. The grouping of information proposed is by major location (site, blocks, floor level etc), by source of drawing (architect, structural engineer, etc), by category, and by construction planning unit. The categories proposed are location drawings, layout drawings, assembly drawings, component drawings and schedules. Location and layout drawings are scheme design drawings and will inevitably be peculiar to each project, but assembly and component drawings and schedules are intended to be "kit of parts" drawings from which a library of standard details can be compiled. Integration of the drawings from different sources is achieved by the use of copy negatives. It is proposed to cross reference only from scheme design drawings to assembly details or to schedules which in turn relate to assembly or component drawings.

The model envisages the use of an elementary coding system to identify construction planning units and cross refer to assembly, component and schedule drawings. Two standard sized drawing sheets only will be used to a standardised layout, to facilitate binding of the drawings and issue to the contractor in book format. Incomplete information will be cross hatched, and variations will be dealt with by the issue of fresh drawings,

numbered to agree with the Architect's Instruction, and showing all the information necessary to comply with that instruction. All project documents and other documents referred to will be listed in the Bill of Quantities and/or in the Specification, as shall all conscious omissions, information given on a preliminary basis, and the designer's dated schedule of future information releases.

To complete the development of the model it is proposed that further study is required to define and agree which performance data used by contractors are of benefit to designers in producing documentation; the best "large general groups" of information for presentation and the most appropriate drawing techniques; architectural plan of work stages and contractors' procedures; an efficient procedure for issue, receipt and registration of project documentation; methods of defining revisions to the information; a coding method for the documentation; and generally useful search patterns.

The Report recommends that the model be developed in sections if possible and tested on live projects as development proceeds. It also recommends that:

(a) Work be put in hand to ascertain users' and producers' information needs in greater depth than has been possible within the time scale of the study.

(b) External documents such as the Standard Method of Measurement and the National Building Specification which affect the structuring of project information should be written or revised in the context of a total information system and not in isolation.

(c) The implications on the provision and structure of project information of different organisational and contractual arrangements in the construction industry should be examined.

(d) The effects of placing the point of design/construct interface at different positions on the model information flow to meet the needs of individual projects should be investigated.

(e) The possibility of providing documents which facilitate the separation of the tender/payment and the production control functions of the bills of quantities should be investigated.

(f) The Study Team on Classification Categories should develop a list of Construction Planning Units as a matter of urgency—there is no such category in any existing system. It should also develop the classifications and lists of further levels of sub-division necessary to the producers and users.

(g) In view of the certainty that many of the existing systems will continue in use for some time, the Study Team on Classification Categories should consider the proposals for convergence of the existing systems made in an Appendix to the Report in order to minimise the differences from the point of view of the recipients of project information.

(h) A short guide should be produced introducing helpful guide lines for the practitioner based on the improvement of his traditional approach, recognising the different needs and economic constraints of the small and large firm.

Appendix 4

Summary of Report on Commodity File

Following the preliminary fact finding survey described in para 4.14.3 of the main report, the Consultants, W S Atkins and Partners, were asked to examine the technical feasibility and commercial viability of the central commodity file. The terms of reference of the study are given in Appendix 1.

There were three major elements of the study—the definition of the data, the consideration of technical alternatives and the cost evaluation of these alternatives.

The data element of the study showed that over 31 million queries are made annually regarding building products, 10 million being posed by architects, nearly 14 million by contractors and over 2 million each by engineers, quantity surveyors and builders' merchants. Answers are at present obtained mainly from manufacturers either from their literature (44%) or their representatives (27%). Telephone calls to manufacturers and merchants account for a further 27% whilst the commercial information houses, including the Building Centres, account for 2%.

The number of manufacturers supplying the construction industry was estimated to be between 10,000 and 14,000 and it was estimated that information on 360,000 products (or 200 million characters of information) would need to be held on the file. For this purpose a product was equated to one sheet of manufacturers' literature.

Fifteen separate systems were analysed and costed, ranging from a simple manually operated card index, through unedited and edited literature, both manually and mechanically operated, to microform and computer based systems. An examination of the problems of file maintenance showed that because of the large amount of data that would need to be stored and up-dated, the manual and mechanical systems were not as efficient as the others and they could not adequately deal with the more complex questions. Neither did their efficiency increase with an increase in the number of questions. They were however easier to set up.

The microform system examined could handle many more complex questions than the manual and mechanical systems and provided good user convenience and browsability. The high cost of the in-house microform reader was a disadvantage. The computer systems could handle the greatest number of enquiries of all types and their cost per enquiry fell with an increase in number of enquiries, unlike the other systems. The possible dialogue between the user and the file was a distinct advantage of the interactive computer systems, and their potential for feedback analysis and links with other computer applications was unique.

Users indicated that they were prepared to pay between £5 and £1,000 per annum for the service. Manufacturers and merchants would in general subscribe to the file, the majority considering £500 a year reasonable. The annual file costs were found to vary from around £$\frac{3}{4}$ million for the simpler system to over £4 million for the more sophisticated computer systems. Enquiry charges would vary from 9/- (45p) to 12/6 (62$\frac{1}{2}$p) for the manual and mechanical systems, 8/6 (42$\frac{1}{2}$p) to 11/2 (56p) for the microform systems and 5/6 (27p) to 10/4 (51$\frac{1}{2}$p) for the computer systems.

Benefits would arise from the time saved by users in searching for information, savings in material costs due to improved searches, savings in labour productivity due to better information on products and their fixings, lower maintenance costs and a net reduction in manufacturers' production, distribution and marketing costs. The net benefit for the microform system was estimated at £5M per annum and for the computer system £10M or between 10% and 20% of the current £50M expenditure on information by the industry.

The greater part of these benefits would be enjoyed by the purchasers or occupiers of buildings and other forms of construction who, ideally, should be charged for the service provided by the file. Under present conditions the charge must be first borne by the industry and subsequently passed on to the prime benefactors. The calculated charges are higher than the industry is currently prepared to pay due essentially to the difference in their assessment between the real and perceived cost of obtaining information. If the charge cannot be passed on, this difference must be reduced by promotional and educational processes during and before implementation.

Appendix 5

Data Co-ordination in Foreign Countries

International co-operation in the work of data co-ordination takes place largely under the auspices of the International Council for Building Research Studies and Documentation (CIB), an international non-government organisational set up at the instigation of the Economic Commission for Europe. A Symposium on "Some Problems of Information Flow in the Building Process" was held by CIB at Rotterdam in September 1970, at which the UK presented papers on the evaluation of information systems, the central commodity file and the co-ordination of computer software and the RIBA presented the CI/SfB Project Information Manual. The UK papers were particularly well received and the subjects they dealt with were among those selected for further study.

In Sweden the Swedish Building Co-ordination Centre (BSAB), which is jointly owned by 17 organisations but is largely financed by Building Research Council funds levied on building contracts, aims to develop a data co-ordination system. Seven of the shareholding organisations are client based, such as the National Board of Public Building and the Federation of Swedish County Councils; three are consultants' organisations, such as the Swedish Association of Consulting Architects; four are contractors' organisations such as the Associated General Contractors and Housebuilders of Sweden and the Swedish Electrical Contractors' Association; and three are professional bodies including the National Association of Swedish Architects and the National Association of Swedish Civil Engineers. The Swedish Building Co-ordination Centre aims to introduce a system covering the following by the beginning of 1972:

Uniform systematization and classification of
Administrative regulations including contracts, contracting regulations and regulations concerning contractors;

Standard General Specifications for buildings, sites, heating, ventilation, sanitation and electrical;

Rules for measuring quantities;

Products and materials register;

Design documents—drawings, specifications, schedules of quantities, bills of quantities and contract documents.

Methods and routine for the systematization of brief and design work, including manual routines for programming, design (drawings, schedules of quantities, specifications, bills of quantities, and specification of contract) and cost planning;

Methods and routines for the systematization of brief and design work by electronic data processing methods, including computer programs for specifications, bills of quantities, cost planning, cost regulation and information feedback.

The Swedish Building Information and Documentation Centre (Svensk Byggtjanst), which has the same range of owners as BSAB, is responsible for building commodity information and—with others—for providing practitioners with general information. It is responsible for the SfB Bureau which administers SfB internationally and is developing the SfB System for use in Sweden.

There is no central organisation for data co-ordination as a whole in France. The Centre d'Assistance Technique et de Documentation du Bâtiment et des Travaux Publique (CATED) is developing a national information system including product information particularly for contractors. CATED is financed by means of a contribution made by building and civil engineering contractors on a percentage basis. Its major effort at the present time is directed to the development of a computer based central commodity file, but technical information on construction, technical solutions and standards will also be capable of being accessed by the system. The work was not preceded by surveys or

specific studies—the need was considered to be apparent and steps were therefore taken to meet it. A second organisation, "Méthode Systematique" is investigating means of rationalising the design process "Méthode Systematique" consists of a group of organisations representing the construction industry, including research centres, professional institutions, and the Department of Equipment and Housing.

The present organisation by which data co-ordination is being developed in Canada is similar to that in this country but the range of work being undertaken is not so comprehensive. An independent survey undertaken by a firm of management consultants reported to the Department of Industry, Trade and Commerce that the Canadian construction industry has a large and costly information system of uncertain quality and efficiency. As a result the Department, assisted by an Industry Advisory Committee on Construction Information Systems, is developing a performance specification for a comprehensive construction information system and is seeking, in association with the industry, the formation of an independent, non profitmaking, financially responsible corporation or similar body having a board of directors representative of the various industry sectors and government to establish, develop and operate the system. The development programme will consider the total requirements of the system under four areas of study:

1. Establish common language or thesaurus;
2. Develop standard method of presenting information (standard format);
3. Conceive storage, retrieval and dissemination system;
4. Propose organisation and management framework.

A limited draft thesaurus has been produced and a central commodity file is now being developed; some preliminary tests of the proposed system are in process.

The cost of poor communications systems in the construction industry has also been recognised in the United States, where it is estimated that over $1 billion is spent annually on communications in the industry. Primary research identified the specification as a unifying item which affects all in the industry and which all affect, and a standard Format for Construction Specifications has been introduced. The Format has been adopted by major Government agencies and has achieved acceptance in the private sector as the best way to organise construction documents. A Central Commodity File based on a microform, computer operated retrieval system that can provide current information on building products to the entire industry has also been developed. Work is proceeding on a computer language and standardised system geared to the construction industry for storage and retrieval of information.

The necessity of data co-ordination and improved communications in the construction industry has been recognised in many other countries including South Africa, Australia, New Zealand, Japan and most Scandinavian and Eastern European countries. In most cases the work is much less advanced than in the UK, and there is less central direction and co-ordination. Many countries are basing their work on the BRS Report which is being increasingly recognised as authoritative. Others are basing national data co-ordination systems on CI/SfB.

Appendix 6

Related Work

This Table shows some of the work already being carried out by organisations on the subjects examined by the Working Party. It is intended only to indicate the organisations involved and the projects now in progress to improve information flow in the industry. The table is not exhaustive and while some of the projects listed are of a major character, others are comparatively small. In some but not all of the subject areas there is considerable collaboration between many of the organisations listed, and co-ordination through common membership of committees etc.

The entries in the last column do no more than identify the nature of the ongoing work and have not been checked with the organisations concerned. Projects to support the Working Party on Data Co-ordination and described in the body of the report have not been included.

List of Abbreviations Used in this Appendix

BCIS	Building Cost Information Service
BLIS	Building Library and Information Service Ltd.
BRS	Building Research Station
BSI	British Standards Institution
C & CA	Cement and Concrete Association
CACCI	Committee on the Application of Computers in the Construction Industry
CEGB	Central Electricity Generating Board
CIB	International Council for Building Research, Studies and Documentation
CIRIA	Construction Industry Research and Information Association
CI/SfB	Construction Index/Samarbetskommitten for Byggradsfragor
CUBITH	Co-ordinated Use of Building Industry Technology for Hospital Building
DEP	Department of Employment and Productivity
DES	Department of Education and Science
DHSS	Department of Health and Social Security
DOE	Department of the Environment
EWF	Electrical Wholesalers' Federation
GLC	Greater London Council
IHVE	Institute of Heating and Ventilating Engineers
ISE	Institute of Structural Engineers
LAMSAC	Local Authorities Management Services and Computer Committee
NBA	National Building Agency
NCC	National Computing Centre Ltd
NDPS	National Data Processing Service
NFBPM	National Federation of Builders' and Plumbers' Merchants
NFBTE	National Federation of Building Trades Employers
RIBA	Royal Institute of British Architects
RIBAS	Royal Institute of British Architects Services Ltd
RICS	Royal Institution of Chartered Surveyors
RRL	Road Research Laboratory
SMM	Standard Method of Measurement
UMIST	University of Manchester Institute of Science and Technology
WSCC	West Sussex County Council

Recommendation	Sponsor	Agency	Objective or Convention
COSTS AND BENEFITS (Para. 2.10)	No work known		
THESAURUS (Para. 4.2)	DOE	BRS	Research project (P22/68) to establish criteria for descriptions of building operations.
	RIBA	RIBAS	Proposal to develop thesaurus for use with next edition of CI/SfB.
	Various (eg Laings, Wates, C & CA, BRS, RRL, Hutton and Rostron)		Development and maintenance of thesauri for different aspects of construction work.
GLOSSARY (Para. 4.2.8)	BSI		Recommendations for selection, formation and definition of technical terms (BS 3669) and glossary of general building terms.
CLASSIFICATION CATEGORIES (Para 4.3)	Some systems embrace a number of classification categories, for example:		
	RIBA DES	RIBAS Technical Co-ordination Working Party	Maintenance of CI/SfB construction indexing manual. Maintenance of the Building Industry Code (as information and classification system)
	Anne Plowden		Development and maintenance of classification for construction industry.
	DHSS		Development and maintenance of CUBITH information and classification system for hospital building.
	GLC	Communications Group	Development and maintenance of a classification and information system.
	WSCC		Development and maintenance of a classification and information system.
	Some systems serve specific purposes and are based on a single category, for example:		
	RICS	BCIS	Maintenance of Standard Form of Cost Analysis utilising building elements as main sub-divisions.
	RICS/NFBTE		Maintenance of Standard Method of Measurement utilising Work Sections as main sub-divisions.
	DEP		Guide to occupational classification in the construction industry.
	Research in progress on construction industry problems assists in defining classification categories, for example:		
	DOE	BRS	Enquiry into operational methods and skills employed.
	DOE	BRS	Studies of productivity on building sites include identification of work elements.
	DOE	BRS	Revision of CIB Master List of Properties.
CODING	Various organisations, particularly those using computers, have developed their own coding systems. Most of the above classifications use a form of code (notation) for indexing and retrieval purposes. Work on commodity identification code is described below.		
COMMODITY CODE Para (4.4)	EWF	EWF Computer Applications Committee/ Luckins T.S.P.	Unified code for electrical commodities.
	NFBPM	National Computing Centre/NDPS	Computer based service for merchants requiring commodity identification code.
CONVERGENCE OF PROJECT INFORMATION SYSTEMS (Para 4.5)	Work concerned with more than one type of project document, for example:		
	DES	Technical Co-ordination Working Party	Drawings, bills of quantities and other project documents structured according to Building Industry Code.
	RIBA H M R Burgess & Partners	RIBAS	Documentation structured according to CI/SfB. Drawing schedules and bills of quantities structured according to CBC.
	West Sussex County Council	County Architect's Dept.	Documentation structured by Department's own system for computer applications.
	GLC	Communications Group	Drawings, bills of quantities and other project documents to be structured by system being developed.

Recommendation	Sponsor	Agency	Objective or Convention
	DHSS		Documentation structured by CUBITH system
	Work concerned with the layout and content of one document, for example:		
	DOE	BRS	Research on bills of quantities (operational format).
	BSI		Standard for drawing office practice for architects and builders (BS 1192).
	Building EDC/RIBA	National Building Specification Ltd.	Preparation of a National Building Specification.
	DOE		Specification for highway engineering.
	IOB	Estimating Practice Committee	Working Party considering information needed by contractors.
	RICS		Recommended use of Fletcher-Moore phraseology.
GRAPHIC SYMBOLS (Para 4.6)	BSI		Standardisation of symbols through B.S. 308, 1192, 1553, 1991 and 3939.
	IHVE		Standardisation of heating and ventilating symbols through IHVE Guide.
	ISE/Concrete Society		Detailing of Reinforced Concrete.
ENGINEERS' NOTATION (Para 4.6.5)	ISE		The standardisation of input information for computer program in structural engineering.
BRIEFING PROCEDURES (Para 4.7)	RIBA		Plan of work.
	DOE		NENK
	DHSS		CUBITH
STATUTORY AND LOCAL AUTHORITY APPROVALS (Para. 4.7)	DOE		Building Regulations.
RELATIONSHIP OF PROJECT AND MANAGEMENT INFORMATION (Para 4.8)	NBA		Computerised programming and costing techniques (COMPACT)
	DOE	CACCI — Sub-Committee on the use of computers in Construction of Buildings	Computer programs for contractors' cost control.
	CIRIA	Loughborough University	Study of contractors' cost control methods.
SMM REVISION (Para 4.9)	RICS/NFBTE	Standing Joint Committee	Standard Method for Measurement for Building Work.
	RICS/NFBTE	Joint Working Party on Measurement Conventions	Review of methods of presenting project data and the role of measurement.
	CIRIA	UMIST	Research into use of bills of quantities in civil engineering.
	ICE	Standard Method of Measurement Revision Committee/UMIST	Revision of civil engineering method of measurement.
	DOE		Standard method of measurement for roads and bridges.
	CEGB		Method of Measurement.
STANDARD LIBRARY OF BOQ DESCRIPTIONS (Para 4.9)	Fletcher/Moore		Standard Phraseology
	Monk & Dunstone		Standard Library of Building Works for computer applications.
	LAMSAC		Library embracing CLASP, SEAC and traditional descriptions for computer applications.
	Independent Computer Services (N.I.) Ltd.		Standard libraries for computer applications.
	DOE		Standard library for computer applications.

Recommendation	Sponsor	Agency	Objective or Convention
	DOE		Standard library for computer applications in the highway field.
	CEGB		Separate libraries of standard descriptions for building and civil engineering works.
	Various others (including GLC, City and County of Bristol, Manchester Regional Hospital Board, etc.)		Standard libraries for computer applications.
STANDARD WORKING DETAILS (Para. 4.11)	Building Centre Trust	BRS	Study of designer's requirements for detail sheet.
	George Trew Dunn		Study of drawings.
	BSI		Standard for drawing office practice (BS 1192).
	RIBA	RIBAS	Standard detail sheets.
	CIRIA	Alex Gordon & Partners	Standard data sheets.
	DOE	CACCI/Loughborough University of Technology	LUCID project to develop standard details of structural reinforced concrete.
SITE INVESTIGATION REPORTS (Para 4.12)	DOE		Site Investigation Studies
	DOE		Standard specification and bill of quantities for boring, sampling and soil testing.
		Agricultural Research Council	Soil Survey data banks.
COMMODITY FILE (Para 4.14)	West Sussex County Council CIRIA/Bristol Building and Design Centre		Development of Computer held file on commodities for use with computer aided design. FIND (Facsimile Information Network Development) project.
	Various (eg Barbour Index Ltd., RIBAS, NBA, Building Centres, BLIS, Wears Milne, Architects' Standard Catalogues, Building, etc.)		Publishing information on commodities and operating information services. Barbour Index Ltd are currently testing a computer based commodity information service.
FEEDBACK (Para 4.15)	No work known		

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Mr J T Redpath CB MBE FRIBA	Director General of Development (Housing and Construction)

Members	**Representing**
Mr W T F Austin BSc FICE FIStructE MInstHE MASCE	Institution of Structural Engineers
Mr J B Behr MA	Construction Industry Research and Information Association
Mr B K Cheele	National Federation of Builders' and Plumbers' Merchants
Mr M D Clarke ARIBA	British Standards Institution
Mr P A Denison	National Council of Building Material Producers
Professor L Fletcher FRICS FIArb	Royal Institution of Chartered Surveyors
Mr A. G. Foster MIHVE	Heating and Ventilating Research Association
Mr R Geary AIOB	National Federation of Building Trades Employers
Mr N Gibbard MA MIHVE	Committee of Associations of Specialist Engineering Contractors
Mr T J Griffiths	Building Research Station, Department of the Environment
Mr M E R Little MA FICE FIStructE MASCE	Association of Consulting Engineers
Mr G Lloyd	National Federation of Construction Unions
Mr C G L Morley CEng FIEE MIMechE	Institution of Electrical Engineers
Dr M H Ogle BSc(Eng) ACGI MICE	Institution of Civil Engineers
Mr T O'Toole ARIBA AADip	Department of the Environment (formerly Ministry of Housing and Local Government)
Mr B Peters DipArch(Dist) ARIBA	Local Authorities Management Services and Computer Committee
Mr J. F. Reeve ARICS FIQS FIArb	Federation of Civil Engineering Contractors
Mr D Russell FIHVE	Institution of Heating and Ventilating Engineers
Mr N K Scott MA BArch FRIBA	Royal Institute of British Architects
Mr R P Sleep MICE FIMunE	Department of the Environment (formerly Ministry of Transport)
Mr W H Stokes	National Computing Centre Ltd
Mr. R. Tully CEng FIMechE FIHVE	Institution of Mechanical Engineers
Mr J D Twells BA(Cantab) ARIBA	Department of Health and Social Security
Mr R Watts	Federation of Associations of Specialists and Sub-contractors
Mr B G Whitehouse ARICS	Department of Education and Science
Mr D Bishop MC MICE ARICS Mr N E Higgitt FRICS Mr W J Reiners BSc FSS	Department of the Environment (formerly Ministry of Public Building and Works)

Secretary
Mr J E Capito VRD

Technical Secretary
Mr B C Edgill ARICS

Department of the Environment,
Directorate General of Development (Housing and Construction)

In attendance :—

Mr D W Azzaro ARICS BSc(Econ) — Leader, Data Co-ordination Branch, Directorate General of Development (Housing and Construction) Department of the Environment

Preface

The Working Party on Data Co-ordination was set up by the National Consultative Council of the then Ministry of Public Building and Works in late 1968, and first met in March 1969. Its terms of reference were:

> "To consider proposals for the improvement of information flow in the construction industry; to advise on all measures necessary to implement the proposals taking into account the need to secure widespread industrial co-operation in the adoption of any uniform system and the need for compatibility as far as possible with existing development in or affecting the industry; and to report to the National Consultative Council".

This is the Final Report of the Working Party, which has previously published only research papers on particular aspects of its work. It proposes the development of a co-ordinated system which will enable information to flow more freely and be used more efficiently throughout the industry, and describes work on:

Project information, including drawings, specifications and bills of quantities;

General information such as trade literature and information concerning materials, products and components;

The syntax or conventions which will co-ordinate these two types of information;

Relevant developments in computer applications.

The results of a cost benefit analysis are included, and recommendations are made for future work which will be necessary to develop the total system.

It is suggested in the Report that an Association be formed consisting of the major users of information systems in the industry—building departments, design offices, contractors etc—to implement the proposals.

This Report represents the completion of an important stage in efforts to improve communications in the construction industry. It is hoped that it will receive widespread discussion and support throughout the industry.

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